TWENTY-YEAR
WATER AND WASTEWATER
SYSTEM BUILD-OUT STUDY
for the
TOWN OF NEWMARKET, NH


JULY 2017

TOWN OF NEWMARKET, NH
EST. DEC. 15, 1727

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70 YEARS 1947 - 2017

TWENTY-YEAR

WATER AND WASTEWATER SYSTEM BUILD-OUT STUDY

FOR THE

TOWN OF NEWMARKET, NH

JULY 2017

THE STATE OF NEW HAMPSHIRE
RICHARD N. DAVEE
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7.10.17

Special thanks to the Town of Newmarket Water and Wastewater Department, Planning Department, and Assessing Department for their dedicated staff's efforts in providing data and insights for this report.

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TWENTY-YEAR

WATER AND WASTEWATER SYSTEM BUILD-OUT STUDY

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Executive Summary

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SECTION 1

EXECUTIVE SUMMARY

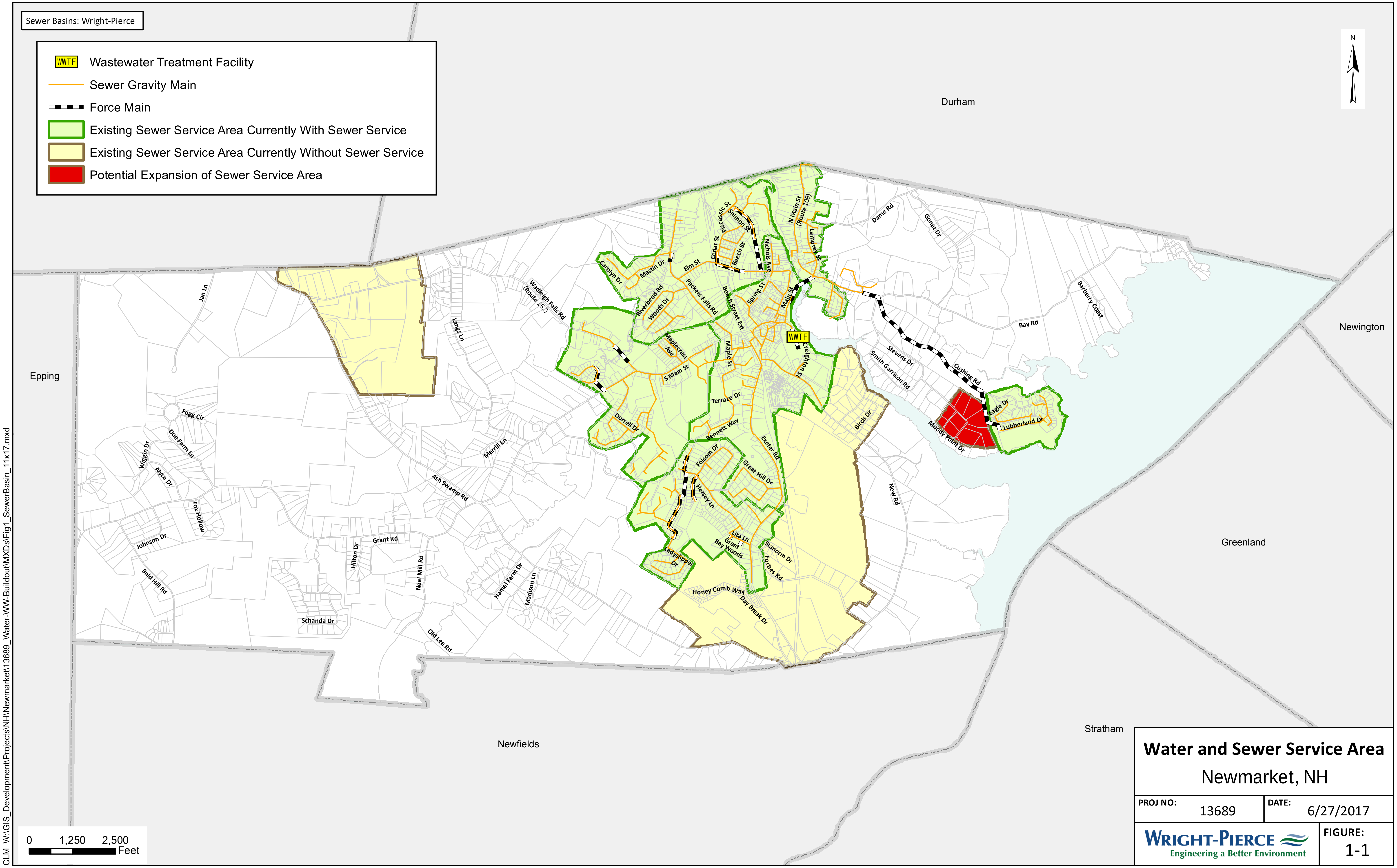
1.1 INTRODUCTION

The Town of Newmarket has a public sewer and water system that serves a large portion of the community. Periodically the town assesses whether it has adequate wastewater treatment capacity and water supply capacity to serve the projected growth within the sewer and water service area of the community.

The last sewer build-out analysis was competed in 2011 and the last water system demand study was completed in 2004. Since then, there have been some changes that motivated the Town to commission an update to these analyses. These changes include zoning changes and discussion about other potential zoning changes that could impact the demands on the water and wastewater infrastructure capacity needs. Also, the recent drought conditions have caused the Town to understand that the safe yield capacity of Bennett and Sewall Wells is substantially less than the historical understanding. This new information makes the need to expand the Town’s water supply capacity more urgent.

The water and sewer service areas identified in past studies included all areas of town except most of the R-1 zoned areas as shown on **Figure 1-1**. This is a reasonable service area considering the higher density development allowed within these areas. For the purposes of this study, this service area will remain largely unchanged from the previous Sewer Build-Out Study except for a small expansion of the service area adjacent to Moody Point as discussed in Section 4.

The zoning in this service area has changed somewhat since the last build-out analysis and there has been discussion about additional changes. In this study, we projected the population growth over the next twenty years in the community, as well as the saturation build-out potential for the water and sewer service area to project the water and sewer capacity needs for the community. We also assessed the impacts that potential zoning/development changes could have on these projections, which is discussed in Section 4.



Sewer Basins: Wright-Pierce
WWTF
Wastewater Treatment Facility
Sewer Gravity Main
Force Main
Existing Sewer Service Area Currently With Sewer Service
Existing Sewer Service Area Currently Without Sewer Service
Potential Expansion of Sewer Service Area
N
Durham
Epping
Newington
Greenland
Stratham
Newfields
WWTF
N Main St (Route 108)
Lamprey St
Salmon St
Piscassic St
Cedar St
Beech St
Nichols Ave
Elm St
Mastin Dr
Carolyn Dr
Riverbend Rd
Woods Dr
Packers Falls Rd
Beech Street Ext
Spring St
Main St
Creighton St
Maple St
Maplecrest Ave
S Main St
Terrace Dr
Durrell Dr
Bennett Way
Exeter Rd
Folsom Dr
Great Hill Dr
Hersey Ln
Lita Ln
Great Bay Woods
Stanorm Dr
Forbes Rd
Ladyslipper Dr
Honey Comb Way
Day Break Dr
Birch Dr
New Rd
Dame Rd
Gonet Dr
Barberry Coast
Bay Rd
Stevens Dr
Smith Garrison Rd
Cushing Rd
Eagle Dr
Lubberland Dr
Moody Point Dr
Wadleigh Falls Rd (Route 152)
Langs Ln
Jan Ln
Fogg Cir
Doe Farm Ln
Wiggin Dr
Alyce Dr
Fox Hollow
Johnson Dr
Bald Hill Rd
Merrill Ln
Ash Swamp Rd
Grant Rd
Hilton Dr
Neal Mill Rd
Hamel Farm Dr
Madison Ln
Schanda Dr
Old Lee Rd
0 1,250 2,500 Feet
Water and Sewer Service Area
Newmarket, NH
PROJ NO: 13689
DATE: 6/27/2017
WRIGHT-PIERCE
Engineering a Better Environment
FIGURE: 1-1
CLM W:\GIS_Development\Projects\NH\Newmarket\13689_Water-WW-Buildout\MXDs\Fig1_SewerBasin_11x17.mxd

1.2 WATER SYSTEM FINDINGS

1. The current average public water system water demand in Newmarket for the past three years is 378,470 gallons per day (GPD) and the maximum day demand is about 574,600 GPD.
2. Based on several assumptions about growth rate and type of development, as discussed in Section 5 of this report, this demand is projected to grow over the next twenty years by approximately 36% to an average 513,190 GPD and to 923,740 GPD on a maximum day basis.
3. The projected growth over the next twenty years will leave the sewer/water service area partially undeveloped and we have projected the future demands on the water system at full build-out (saturation) of the water and sewer service areas at 1,022,692 GPD on an average day basis and to 1,840,842 GPD on a maximum day basis. This represents a 170% increase over current day demands.
4. The potential changes to zoning and to development within the water service area, as discussed in Section 4, have the potential to reduce the saturation build-out demand to about 764,620 GPD on an average day basis and to 1,376,310 GPD on a maximum day basis.
5. Best practice in the public water supply business is to:
   A. Have sufficient water to meet average system demands during drought conditions (safe yield), and
   B. Have sufficient safe pumping capacity to deliver in 18 hours the maximum day demand with the largest pump off-line (i.e., safe pumping capacity).
6. Currently the Town has three water supply wells.
7. The Bennett and Sewall wells have been the main source of water for the community for many years. Historically these wells were thought to have a safe yield of 200 and 260 gpm, respectively. The recent drought conditions in 2016 resulted in revised safe yield estimates of 110 and 155 gpm, respectively. This is a major reduction in Town's water supply capabilities.
8. In 2016, the Town put the MacIntosh well on-line. This well has a safe yield of 300 gpm, but due to water quality issues, this well must be blended with water from the other two wells. As a result, Bennett and Sewall Wells must be operating at 100% of their safe yield in order to pump MacIntosh at 300 gpm.
9. The Town has permitted a fourth well (Tucker Well), but has not developed this well or tied it into the distribution system. This well has a permitted capacity of 275 gpm, but like the

Macintosh Well, will likely be limited by water quality issues to less than this capacity unless the water is treated.

10. The safe yield of the Town's three operating wells is currently 813,600 GPD which is above the current and twenty-year build-out demand projections. However, having Sewall Well offline for any reason reduces the safe yield to 309,600 GPD (see Section 7), which is significantly below the current and projected future needs.
11. The safe pumping capacity of the Town's wells is currently 518,400 GPD, which is below what industry standards suggest for current conditions and substantially less than what is needed to meet future conditions.
12. The Town needs to expand both safe yield and safe pumping capacity of the water system to meet to current and projected demands consistent with industry best practices.
13. The Town has explored options to expand its water supply capacity in past engineering studies, including:
    A. Construction of a fourth well (Tucker Well),
    B. Construction of a water treatment plant to treat the Macintosh and Tucker wells to allow utilization of their full capacity potential,
    C. Recharging the Bennett and Sewall Wells aquifer with river water to increase their safe yield, and
    D. Identification of other potential well sites.
14. To solve the Town's immediate needs, some variation of Options A and B above are likely to be the most attractive strategy for the Town.
15. While Options A and B above would substantially increase the safe yield and safe pumping capacity of the water system, additional measures could be required in the future depending on actual growth rates. To further increase the safe pumping capacity, a backup well at the MacIntosh or Tucker Well Sites, or a new well on a new site, may also be needed.
16. Based on past studies, the costs of Options A and B along are estimated at $5.7 million in 2017 dollars.
17. Before initiating the design of solutions to the Town's water supply issues, additional study is recommended to confirm and fine-tune solutions, costs, funding options, financial capability, implementation options, etc.

18. Given the fact that Town is not in compliance with industry best practices relative to the safe yield and safe pumping capacity of its water supplies compared with the town's water demands, it is recommended that the Town proceed with this evaluation in the near future.
19. Past studies identified other potential areas where future wells may be located. While no additional wells are suggested in the near term over and above what is discussed above, the Town may want to preserve the highest priority well sites to maximize future options.

1.3 WASTEWATER SYSTEM FINDINGS

1. The Town is currently upgrading its wastewater treatment plant to achieve new nitrogen standards and the upgraded facilities should be operational by August 2017.
2. The capacity of a treatment plant is a function of a variety of factors such as average flow, peak flow, and pollutant loadings, as discussed in Section 6 of this report.
3. In addition to receiving residential and commercial sewage, the treatment plant receives a meaningful amount of infiltration and inflow (I/I) that makes its way into the sewer system. The quantity of I/I varies seasonally and from year-to-year based on rainfall and other factors and has an impact on the capacity available for growth. While the quantity of I/I in Newmarket is not an insignificant fraction of the total flow, it is on the low end of the industry norm and reflective of the extensive effort the Town has made to reduce I/I.
4. The annual average flow to the treatment plant over the past several years has ranged from 0.41 million gallons per day (mgd) to 0.65 mgd with the I/I ranging from 20% to 54% of these annual averages. Maximum month flow to the treatment plant has been as high as 1.04 mgd.
5. In addition to design capacity considerations, the Federal discharge permit restrictions are a key capacity consideration. This is particularly true in Newmarket because the water quality limitations in Great Bay will make obtaining a permit increase in the future very difficult at best and, if possible, very costly. Currently the Town is permitted to discharge up to 850,000 GPD or 0.85 mgd on a monthly average basis. The Town's intent was to obtain a permit for an annual average flow rate of 0.85 mgd. The federal permit, as written, would significantly limit the Town's growth potential. Discussions were initiated with EPA back in 2014 to have this permit revised consistent with the Town's original intent and consistent with how other permits in the region have been issued. While EPA seemed receptive to this concept, the permit has not yet been revised and it is very important for the Town to stay on top of this

issue until the permit is changed. For purposes of this study, we have assumed that the permit will be changed.

6. In 2016, the annual average flow rate to the treatment plant was approximately 0.42 mgd. This was a drought year with minimal precipitation and similarly low inflow and infiltration (I/I) flows. In a worst case, wet year, it is expected that this annual average flow would be on the order of 0.58 mgd, leaving about 0.27 mgd (270,000 gpd) of permitted capacity for growth.
7. Based on several assumptions about growth rate and type of development, as discussed in Section 5 of this report, this annual average flow is projected to grow over the next twenty years by approximately 29% to 0.75 mgd, which is within the permitted capacity of the treatment plant.
8. Under a worst case full build-out saturation scenario of the sewer service area as currently zoned (build-out Scenario #1), the annual average flow (on a wet year with a worst case I/I allowance) to the treatment plant is projected to grow to 1.2 mgd. This is greater than the current permitted capacity of the wastewater treatment plant. As is discussed in Section 5 of this report, the Town would ideally limit growth such that the saturation build-out would be within the current permit limit of 0.85 mgd.
9. This worse case build-out scenario (Scenario #1) assumes textbook allowances for industrial development water and sewer demands. These assumptions are very conservative and higher than what the existing industrial park is producing for water demands. If the remaining commercial/industrial land were developed with water demands similar to the existing industrial park, and if other discussed zoning and development changes were made, the saturation build-out scenario would result in a full build-out demand of between 1.0 and .89 mgd (Scenario #2 and Scenario #3).
10. The potential changes to zoning and to development within the sewer service area, as discussed in Sections 4 and 5 (Scenarios #2 and #3), lower the full build-out demands, but are still above the current wastewater permit limit of 0.85 mgd.
11. While the permit capacity of the wastewater treatment plant can accommodate the twenty-year projected growth, it cannot accommodate the theoretical worse-case saturation build-out scenario (Scenario #1) as currently zoned. Given the significant challenge associated with obtaining an increase in permitted capacity, demand management strategies are strongly recommended. They could include:

- Control Type of Future Industrial Growth: Reduce the saturation build-out demands by strictly controlling the type of industrial growth permitted in the future (commercial/industrial establishments with low-to-moderate water/sewer demands).
- Future Zoning Changes: Existing undeveloped industrial zones (B-2 and B-3) with potentially high future per-acre water demand could be rezoned to a classification with lower potential water demand; and/or
- Inflow and Infiltration Control: Continue Town-wide efforts to identify and remove significant sources of inflow and infiltration in the existing sewer system.

12. Moving forward it will be important to track the growth in flows and loads to the treatment plant to ensure that growth does not exceed the design or permitted capacity of the plant.
13. There is a potential that Newfields may consider pumping their sewage to Newmarket to avoid having to build their own advanced treatment plant. While there could be some operational economies of scale for both towns, Newmarket has a limited permitted WWTF discharge capacity available. We would suggest this scenario only be considered if EPA were willing to provide a permit increase of 0.117 mgd to Newmarket's permit to accommodate Newfields' wastewater flow. Before deciding, a comprehensive evaluation would be required to fully define the impacts to the WWTF capacity, and the long-term economic benefits to the Town.

1.4 RELATED ISSUES

1.4.1 Hydraulic Studies and Pipe Networks

The focus of this study was on the capacity of the Town's water supplies and wastewater treatment plant relative to projected Town demands on these systems. Town development within the Town's water and sewer service areas will also impact the Town's water and sewer piping systems. It will be necessary to assess how new development will be connected to the Town's water and sewer system and whether new development causes the need to expand the capacity of any existing water and sewer pipe lines or pumping stations. It is also important to determine the cost of providing the water and sewer service to new development and new users. This work is outside the scope of this study and will need to be commissioned ahead of planned development.

1.4.2 Cost Recovery System Review

When considering the growth impacts on water and sewer infrastructure systems, it is often advisable to evaluate the adequacy of the Town's cost recovery systems (e.g., user charge system, impact fees, etc.). Industry best practices suggest that user charge systems recover not only the routine operations and maintenance cost but also include depreciation cost so the community has adequate resources to sustainably maintain all its water and sewer infrastructure assets. With respect to managing the financial impacts of development on the water and sewer system, industry best practice is to have the beneficiaries of new development pay for the cost to service the development, as opposed to having existing users subsidize the cost of growth. This usually takes the form of an impact fee or connection fee. Depending on when the Town's cost recovery systems were last updated, the Town may want to review and update these systems as appropriate.

1.4.3 Growth Agenda Coordination with Water and Sewer Department

The Town's zoning and growth agenda have a very significant impact on the water and sewer system. Any change to either should include close coordination with the water and sewer department.

1.4.4 Non-point Source Nitrogen Control and Relationship with Development

As discussed in Section 8.4.4 of this report, the Town has state and federal regulatory mandates to control non-point sources (NPSs) of nitrogen pollution, and these mandates should inform and impact the Town's development standards moving forward, as it is significantly more economical to build low impact development strategies to minimize nitrogen pollution into new projects than to retrofit existing projects with nitrogen control strategies.

SECTION 2

Introduction

SECTION 2

INTRODUCTION

2.1 PROJECT BACKGROUND AND OBJECTIVES

The goal of this study is to determine whether the Town has adequate water supply and wastewater treatment plant capacity to accommodate future community growth. A twenty-year sewer system build-out study was completed for the Town in 2011. This study has been commissioned so that an updated twenty-year projection can be made and the following items can be added for consideration:

- Consideration of both the water and wastewater system in the build-out analysis
- Changes to zoning regulations since 2011
- Potential future zoning changes, which could influence build-out
- Recent drought conditions, which may influence the safe yield of the Town's drinking water supply wells

This build-out study utilizes information from past studies and analyzes new data to provide estimates of build-out scenarios and water and wastewater system capacity. The following key tasks have been identified and addressed in this study:

- Identify the flow and pollutant load capacity of the Town's new wastewater treatment plant.
- Estimate the safe yield and safe pumping capacity of the Town's water supply wells.
- Document the Town's current annual average and maximum day demands on the water supply system.
- Review past wastewater treatment flow and precipitation data and estimate the range of sewer system infiltration/inflow.

- Define the magnitude of the remaining safe yield and safe pumping capacity of the water supply wells.

- Coordinate with the Town’s Planning Department and perform a build-out analysis of developed and undeveloped land in Town that is or will likely be served by public water and/or sewer service considering current and potential future zoning, geography, natural resources and proximity to existing infrastructure systems.

- Project the future water supply and wastewater treatment capacity needs due to the projected build-out of the Town under current and potential future zoning scenarios

- Determine if the Town has adequate water supply and wastewater treatment capacity to meet long-term build-out of the Town.

- Determine if the Town has capacity to accept sewage from neighboring communities.

- Identify management and monitoring strategies to optimize the Town’s existing water supply system and wastewater treatment system.

- If it is determined that the Town does not have adequate water systems capacities available, determine how much growth the Town can accommodate before capacities are exceeded. This will indicate how much time is available to either increase capacity of Town infrastructure systems or modify the Town’s growth planning agenda.

- Identify and estimate the cost of strategies to address any identified need for expanded wastewater treatment or water supply.

- Summarize findings in a draft report.

- Meet and review the report with the Town staff.

- Incorporate review comments and finalize report.

2.2 SUMMARY OF PRIOR REPORTS

During the preparation of this study, information from the following reports was reviewed, considered, and, in some instances, incorporated into this report.

Final Draft Report- Twenty Year Sewer Build-out Study- February 15, 2011, prepared by Underwood Engineers, Inc.

Final Report- Pilot Study Report Macintosh Well Treatment Alternatives- December 2012, prepared by Weston and Sampson Engineers, Inc.

Final Report- Delineation of Wellhead Protection Area- Newmarket Plains Aquifer- December 1999, prepared by Dufresne-Henry.

Draft- Water Storage and Distribution Improvements Preliminary Design Report- June 21, 2006, prepared by Underwood Engineers, Inc.

Final Letter Report- Water System Demand Study for the Town of Newmarket, New Hampshire- August 2004, prepared by Metcalf and Eddy.

Final Hydrogeologic Investigation for Newmarket Production Wells #3 (NGD-2B) and #4 (NGD-1A)- August 2010, prepared by Emery and Garrett Groundwater, Inc.

Summary of the Bennett and Sewall Well Assessment Newmarket Plains Aquifer- March 2016, prepared by Emery and Garrett Groundwater Investigations, LLC.

Town of Newmarket, New Hampshire- Water System Update and Capital Improvement Plan- September 9, 2011, prepared by AECOM.

Town of Newmarket Master Plan- August 2001- Latest Amendment April 2013, prepared by the Strafford Regional Planning Commission and the Town of Newmarket, NH.

Results of Phase II Investigations Using Artificial Recharge to Enhance the Withdrawal of Groundwater Resources from the Newmarket Plains Aquifer- February 2009, prepared by Emery and Garrett Groundwater Investigations, LLC.

Annual Water Conservation Plan, 2017, prepared by the Town of Newmarket Water and Wastewater Department

SECTION 3

Existing Water and Wastewater Flow Analysis

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70 YEARS 1947 - 2017

SECTION 3

EXISTING WATER AND WASTEWATER FLOW ANALYSIS

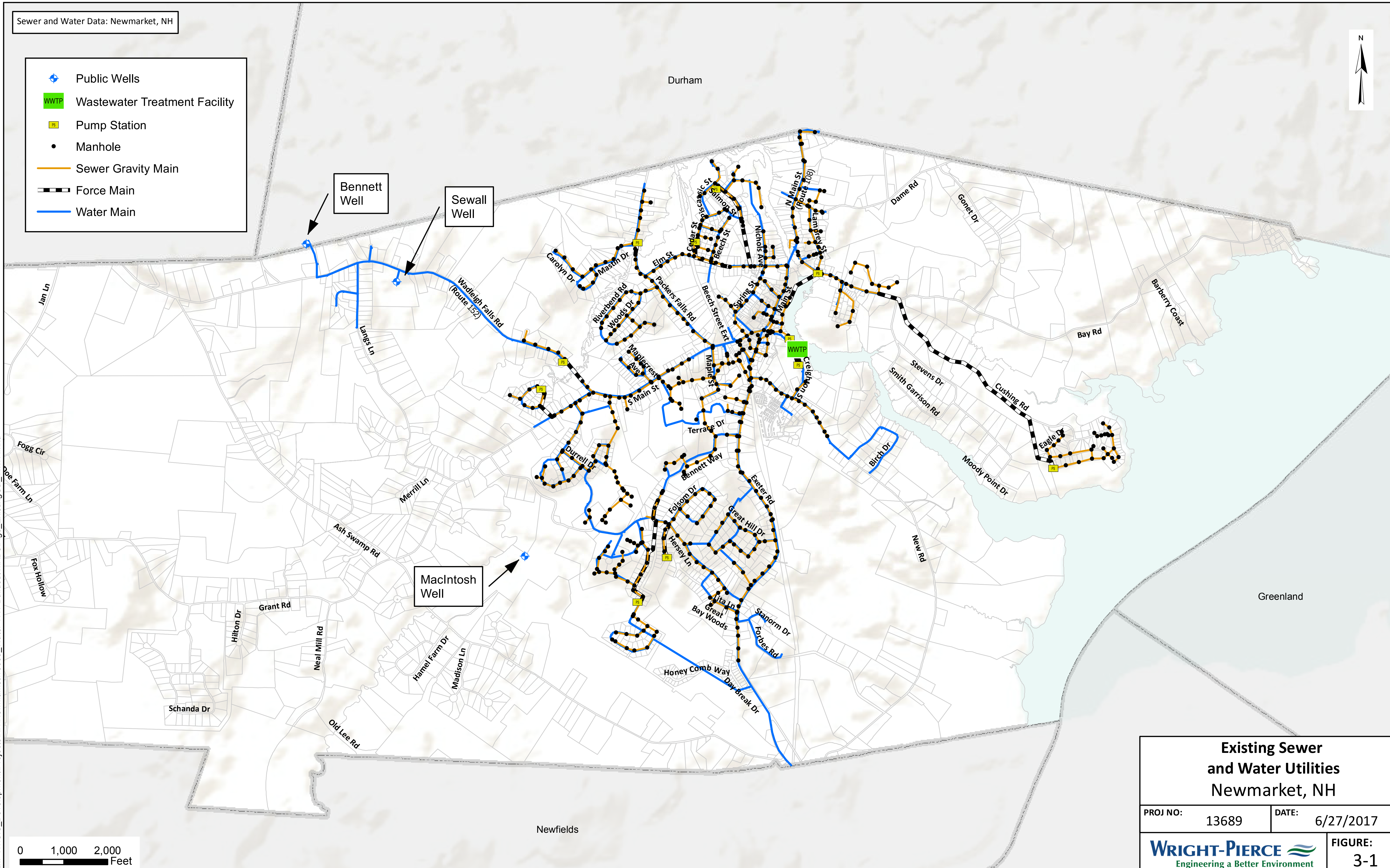
3.1 WATER AND WASTEWATER BILLING ANALYSIS

The existing water consumption and sewage generation rates are estimated based on water pumping records, flow meter data and billing information provided by the Town of Newmarket. **Figure 3-1** shows the area of the Town presently being served by public water and sewer. The Town of Newmarket Water and Wastewater Department, Planning Department, and Tax Assessment Department have all put forth considerable effort to ensure the data supplied for this study is as accurate as possible. Billing data for the years 2014 and 2016 was analyzed to estimate the average water consumption and sewer discharge per unit in the system. These two bill years' data are believed to provide the most recent and accurate data due to possible discrepancies with 2015 billing information.

Newmarket water and sewer users are billed on a per hundred cubic foot (CF) basis for both water and sewer. There are 748 gallons in 100 cubic feet of water. Water is metered entering a home or business and the recorded value is used to determine an equivalent sewer flow exiting the home or business. The Town currently has approximately 3,695 units with water service and 3,580 with sewer service. Billing data was classified as shown in **Table 3-1** by the Town of Newmarket Water and Sewer Department based on usage, unit type, and primary unit use.

TABLE 3-1
AVERAGE BILLED WATER AND SEWAGE FLOWS BY USER CLASSIFICATION

User Class	Number of Units on Water	Billed Water Demand (GPD/unit)	Number of Units on Sewer	Billed Discharge to Sewer (GPD/unit)
Single Units	1,504	106	1,450	100
Multi-units	1,813	78	1,802	77
Commercial	94	211	68	209
Mix Units	245	124	225	90
Municipal	33	401	30	397
Other	6	60	5	63



Existing Sewer and Water Utilities
Newmarket, NH

PROJ NO: 13689
DATE: 6/27/2017

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Engineering a Better Environment

FIGURE: 3-1

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Billing classifications were then further consolidated into zoning classifications to simplify the study. Zoning classifications have been limited to residential, commercial, and industrial based on the predominant uses of the zoning districts, as described in the Newmarket Zoning Ordinance dated 08/07/13. For this study, units have been broadly classified to estimate overall system demand and flow.

When billing sewer flow, the Town does not apply a factor to metered water usage to account for water which is not discharged to the sewer system. This study applies a 10% reduction to billed water values when estimating sewer discharge to account for water lost through consumption, yard watering, and other non-sewer collection related activities. **Table 3-2** displays estimated average flow per unit. These values will be used throughout the build-out analysis. It should be noted that 2011 Twenty-Year Build-Out Study (Underwood Engineers) used similar values and the 2004 Water Build-out Analysis used much higher values. With Town input, we have elected to use actual metered flows as a realistic method to determine Average Flows by Zoning Classification. It should be noted that these values could change depending on several variables such as weather patterns, associated water restrictions, type of development, etc.

TABLE 3-2

ESTIMATED AVERAGE FLOWS BY ZONING CLASSIFICATION

Billing User Class	Billing User Classes Included	Number of Units on Water	Water Demand (GPD/Unit)	Number of Units on Sewer	Factored Discharge to Sewer (GPD/unit)
Residential	Single, Multi, 1/2 Mix Units	3,440	105	3,365	95
Commercial	Commercial, 1/2 Mix Units	216	162	180	145
Industrial Per Existing Billing	Municipal, Other Units	39	349	35	314
Industrial- Per Buildable Acre	Municipal, Other Units		825*		750*
* Based on future sewer discharge of 825 GPD per buildable acre w/10% reduction from water demand.					

Most units using Town water and sewer can be considered residential. There are more users of Town water than Town sewer, although the difference is not great enough to considerably effect the difference between water demand and sewer discharge. In the future, should development in currently unserviced areas create a greater demand for the extension of either water or sewer service, but not both, the difference may need to be considered further in build-out projections.

Actual billing data is available from users classified as industrial through the end of 2016. Using billing data, it was estimated that for industrial users in 2016, average water demand was 349 GPD and sewer discharge was 314 GPD (90% of water demand), which is indicative of “dry” types of industrial development such as a warehouse. Future water demand and sewer discharge for industrial facilities is difficult to predict due to the variety of facilities which could be constructed or operated in these areas. If a higher-water demand or higher sewer discharge facility is constructed in an industrial zone, it will have a much greater flow than a warehouse in the same zone.

To be conservative with future projections, this study will use the same value as previous studies for calculating future industrial user flows after 2016. Previous studies assumed that wastewater flows of 750 GPD per buildable acre could be produced in industrial zones, which is typical of industrial users with moderate wastewater generation. It is estimated that this number is 90% of the water demand, resulting in an estimated water demand of 825 GPD per buildable acre.

It must be noted that there are specific industrial users, like a paper mill or a large brewery, which could have substantially higher water/wastewater systems demands. For this study, it is assumed that Newmarket will not be developed with large industrial users of this nature. Only industrial development with low/moderate water and wastewater demands were considered as part of this study.

3.2 EXISTING WATER FLOW ANALYSIS

3.2.1 Water Loss

The Town of Newmarket water system is currently supplied by local groundwater sources. The Town withdraws water primarily from the Sewall Well and the Bennett Well. In 2016, the MacIntosh Well facility was constructed and put into operation. The Town's water supply is discussed in more detail in Section 7 of this report. The total water measured as being pumped from the wells exceeds the total water metered at all customer locations. This phenomenon is characterized as the system water loss which can be attributed to a variety of sources including water system flushing, fire department use, leaking water mains, and inaccurate water meters. Annual water loss was estimated over a 10-year period using well water supply and billing data. Annual water loss is presented in **Table 3-3** below.

It should be noted that since the spring of 2004, the Water Department has not completed a flushing program to conserve water. In the future, it is anticipated that the flushing program will be reactivated and water loss totals will increase. Accordingly, we have increased the water loss estimates to 15% of total pumped water to account for this in future water demand projections.

TABLE 3-3

ESTIMATED ANNUAL WATER LOSS

Year	Annual Water Billed (per 100 CF)	Annual Water Billed (gal/yr)	Annual Water Pumped (gal/yr)	Annual Water loss (%)	Annual Water Loss (gal/yr)	Average Daily Water Loss (GPD)
2006	162,421	121,490,908	168,030,185	28%	46,539,277	127,505
2007	168,926	126,356,648	174,070,230	27%	47,713,582	130,722
2008	161,605	120,880,540	150,629,196	20%	29,748,656	81,503
2009	156,418	117,000,664	164,500,196	29%	47,499,532	130,136
2010	163,041	121,954,668	162,873,294	25%	40,918,626	112,106
2011	173,373	129,683,004	143,068,308	9%	13,385,304	36,672
2012	179,715	134,427,000	147,256,654	9%	12,829,654	35,150
2013	174,506	130,530,488	136,850,396	5%	6,319,900	17,315
2014	175,428	131,220,144	137,644,762	5%	6,424,618	17,601
*2015**	-	-	*137,169,325*	-	-	-
2016	171,877	128,564,000	141,981,080	9%	13,417,080	36,759
* Due to a switchover to monthly billing from a staggered billing period, flows billed did not reflect data gathered from well pumping.						

Improvements to the distribution system and water monitoring capabilities have resulted in annual water loss quantities to significantly decrease since 2006. Annual water loss reached its recorded lowest (5%) in 2013 dropping from a recorded high (29%) in 2009. As of 2016, Newmarket's water loss is estimated at 9%, or 36,759 GPD, of the overall water pumped. Acceptable water loss, according to industry standards and AWWA M36 "Water Audits and Loss Control Programs", is 10% of the water supplied to distribution. It is estimated Newmarket has had water losses below industry standard levels since 2011. For the 2037 build-out, to be conservative, it has been assumed that water loss will be 15% of future source water pumped.

3.2.2 Peak Existing Water Demands

The Newmarket Water and Sewer Department provided peak day pumping values for the Bennett and Sewall Wells from 2014 to 2016. To calculate a peaking factor which could be applied to future flows, the peak system water demand was divided by the average day flow for each year and averaged.

$$Peak\ Day\ Ratio = \frac{Peak\ Day\ Flow}{Average\ Day\ Flow}$$

The resulting average peak day ratio was calculated to be 1.52 for the average of 2014 to 2016 period. Peaking ratio data is shown in **Table 3-4**.

TABLE 3-4

PEAK DAY WATER FLOW RATIO

	Bennett Well (GPD)	Sewall Well (GPD)	Total (GPD)
2014 Peak Day	237,850	333,030	570,880
2014 Average Day	159,329	218,418	377,747
		2014 Peak Day Flow Ratio	**1.51**
2015 Peak Day	267,260	369,160	636,420
2015 Average Day	159,231	216,576	375,806
		2015 Peak Day Flow Ratio	**1.69**
2016 Peak Day	206,570	309,950	516,520
2016 Average Day	154,673	227,194	381,867
		2016 Peak Day Flow Ratio	**1.35**
		Average Peak Day Flow Ratio	**1.52**

Water conservation measures, such as Town-wide water use restrictions and the abandonment of hydrant flushing, have been in place for multiple years. This study does not consider how the lifting of water restrictions may affect the behavior of users. A loosening of these restrictions may cause water demand to rise above the demands of the past few years. A 2004 water demand study for the Town assumed a water peaking ratio of 1.8 as compared to our calculated average peak day flow ratio of 1.52. ***To account for potential increasing water demand when water restrictions are lifted, this study will also use a water peaking ratio of 1.8 to calculate future Peak Day water demand.***

3.3 EXISTING WASTEWATER FLOW ANALYSIS

3.3.1 Wastewater Infiltration and Inflow

In addition to the sewage discharged to the Town's sewer system, the sewer system receives flow from groundwater leakage (infiltration) and surface water leakage (inflow) into the sewer system. Infiltration and inflow (I/I) into the sewer collection system was estimated by comparing billed water data with metered influent flows at the wastewater treatment facility (WWTF). These values are obtained from water meters at individual homes and a flow meter located at the main influent pump station to the WWTF. The raw water and wastewater data for this study was provided for use by the Town and are assumed to be accurate for the purposes of this evaluation. Billed water values were reduced by 10% to account for billed water not discharged to the sewer system. Wastewater I/I in the Town of Newmarket's sewer collection system is estimated in **Table 3-5** by subtracting 90% of the total annual water billed from the total measured influent wastewater flows at the WWTF. It should also be noted that presently there are 115 more water customers than wastewater customers. This difference amounts to approximately 3% more water being billed than what reaches the WWTF. We take this difference into account when determining the I/I allowance to use in the flow projections.

TABLE 3-5

ESTIMATED WASTEWATER SYSTEM INFILTRATION AND INFLOW

Year	Annual Water Billed (gal/yr)	Influent at WWTP (gal/yr)	I/I (gal/yr)	I/I % of Influent	I/I (GPD)
2008	120,880,540	237,531,500	128,739,014	54%	352,710
2009	117,000,664	188,224,700	82,924,102	44%	227,189
2010	121,954,668	161,218,000	51,458,798	32%	140,983
2011	129,683,004	188,739,300	72,024,596	38%	197,327
2012	134,427,000	158,737,000	37,752,700	24%	103,432
2013	130,530,488	168,652,000	51,174,560	30%	140,204
2014	131,220,144	147,917,000	29,818,870	20%	81,696
**2015*	-	151,494,000	-	-	-
2016	128,564,000	151,110,000	35,402,400	23%	96,993
* Water Billed for in this year not accurate due to a billing data discrepancy.					

Improvements in the collection system, drought conditions and wastewater monitoring capabilities at the treatment facility have led to a decrease in I/I in the collection system since 2011. Collection system improvements included rehabilitation of the New Village sewer basin area (2011) and continued town-wide sewer manhole rehabilitation efforts (2010 – 2015). However, I/I quantities can vary significantly from year-to-year depending on precipitation patterns and quantities. As can be seen by comparing **Table 3-5** and in **Figure 3-2**, the highest I/I quantities occurred on the wettest years.

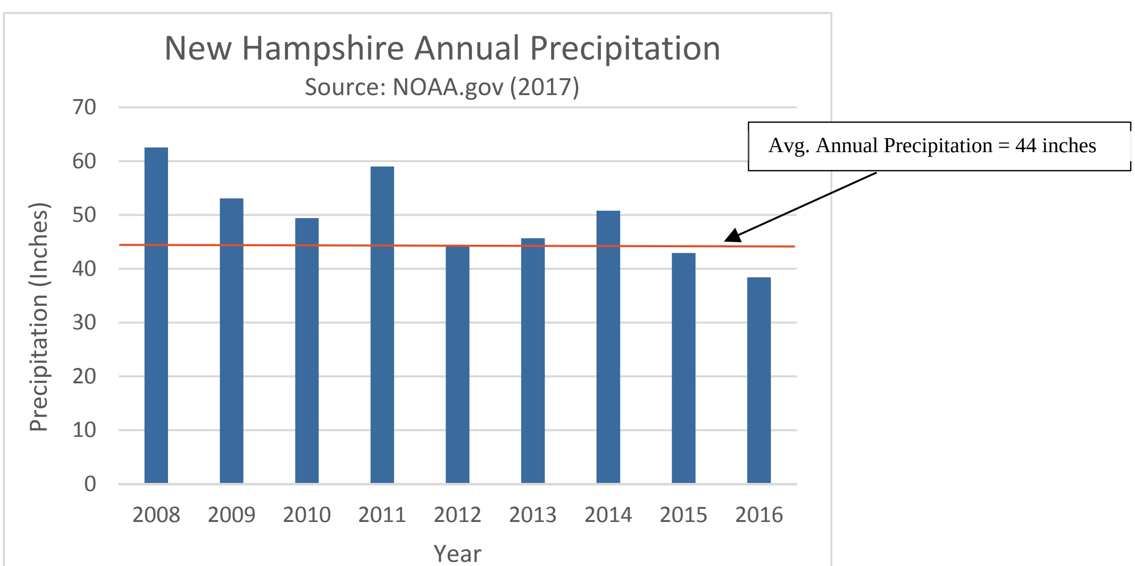


Figure 3-2: New Hampshire Precipitation (2008-2016)

When estimating an appropriate I/I allowance for projected build-out analysis, it is important to project the quantity of I/I that would enter the sewer system in a high precipitation year. The 2011 Twenty-Year Build-Out Study (Underwood Engineers) used an average I/I rate of 300,000 GPD for 2009, and 388,000 GPD for the 2030 build-out projections. For this evaluation, the baseline existing year-average per day I/I quantity was estimated to be 264,000 GPD using the 90th percentile from the previous 8 years of I/I flow data. This value is lower than the I/I values used in the 2011 Twenty-Year Sewer Build-Out Study (Underwood Engineers). The lower I/I value is based on updated flow information and the fact that the Town has continued to improve at reducing I/I.

For I/I rates attributed to wastewater flows added to the system, the daily minimum WWTF flow rates were compared with the overall daily flow rates. Using this approach, the average I/I rates were analyzed from 2008-2016 and found to be approximately 33% of the total influent wastewater flow. For purposes of the build-out projections, annual average I/I rates associated with <u>additional sewage flows</u> will be estimated at 30% of the additional sewage flow. This is a conservative assumption for planning purposes. Ideally, future development would result in less I/I than 30%. Minimizing I/I associated with new developments is more economically accomplished through stringent performance standards and rigorous inspection as compared with post-construction rehabilitation strategies.

Based on Wright-Pierce's experience in communities throughout New England, Newmarket, overall, has less I/I than most older communities, reflective of the Town's historic efforts to reduce I/I. However, the observed high maximum-hour influent flow peaking factor indicates that significant sources of inflow (e.g., building drains, roof leaders, etc.) potentially exist in the collection system. The Town should continue efforts to monitor, identify, reduce and remove I/I where appropriate. Particular focus should be given to older sections of the Town's sewer system known to be more significant contributors of I/I.

3.3.2 Existing Peak Wastewater Flow

The existing peak wastewater flow was determined using actual data over the five years. Current maximum-day and maximum-hour flows are 1.36 million gallons per day (mgd) and 3.20 mgd based on the 99.5th and 99.9th percentiles, respectively. These maximum-day and maximum-hour values equate to peaking factors (P.F.) of 2.8 and 6.0, respectively (Table 3-6). For reference, these peaking factors compare to typical design guidelines of 2.4 for maximum-day peaking factor and 4.0 maximum-hour peaking factor. Measured flows from the WWTF influent flow meter indicate the average daily wastewater collection flow from 2008 to 2016 was approximately 0.48 mgd including both wet and dry years. **Table 3-6** below shows estimated 2017 peak sewer flows using the proposed peaking factors.

TABLE 3-6
ESTIMATED EXISTING (2008-2016) PEAK SEWER FLOWS

Average Day Flow (mgd)	Max Day (24 hour)		Max Hour Flow	
	mgd	P.F.	mgd	P.F.
0.48	1.34	2.8	3.2	6.0

Note:
1. For reference – peak 24-hour reported as 1.4 mgd and peak on max day reported as 3.20 mgd based on previous WWTF reports.

The existing average day flow estimate form 2008-2016 (0.48 mgd) provides a good estimate of what the recent long-term average of sewer flows have been. However, the Town's sewer system must be capable of conveying and treating flows which account for years of higher precipitation such as 2008 and 2011 (see **Figure 3-2)**. As a result, the existing average day wastewater flow, including allowance for a typical wet year I/I, is estimated at **0.58 mgd**. This estimated wastewater flow is a conservative estimate for a typical worst case "wet year" and is used in subsequent report section for determining remaining WWTF capacity. For future sewer projection estimates in the build-out section of this study, the peaking factors shown in **Table 3-6** are used for design peaking factors are used for all sewage flows.

Section 6 of this report addresses the pollutant loadings to the WWTF associated with the flows.

SECTION 4

Existing and Proposed Zoning/Development Scenarios

WRIGHT-PIERCE
Engineering a Better Environment
70 YEARS 1947 - 2017

SECTION 4

EXISTING AND PROPOSED ZONING/DEVELOPMENT SCENARIOS

4.1 INTRODUCTION

To estimate future demands on the water and sewer system, the development potential must be assessed. The first step in the process is to evaluate the sewer and water service area and then to evaluate existing and possible future zoning and development scenarios within the sewer and water service area.

4.2 SEWER AND WATER SERVICE AREA

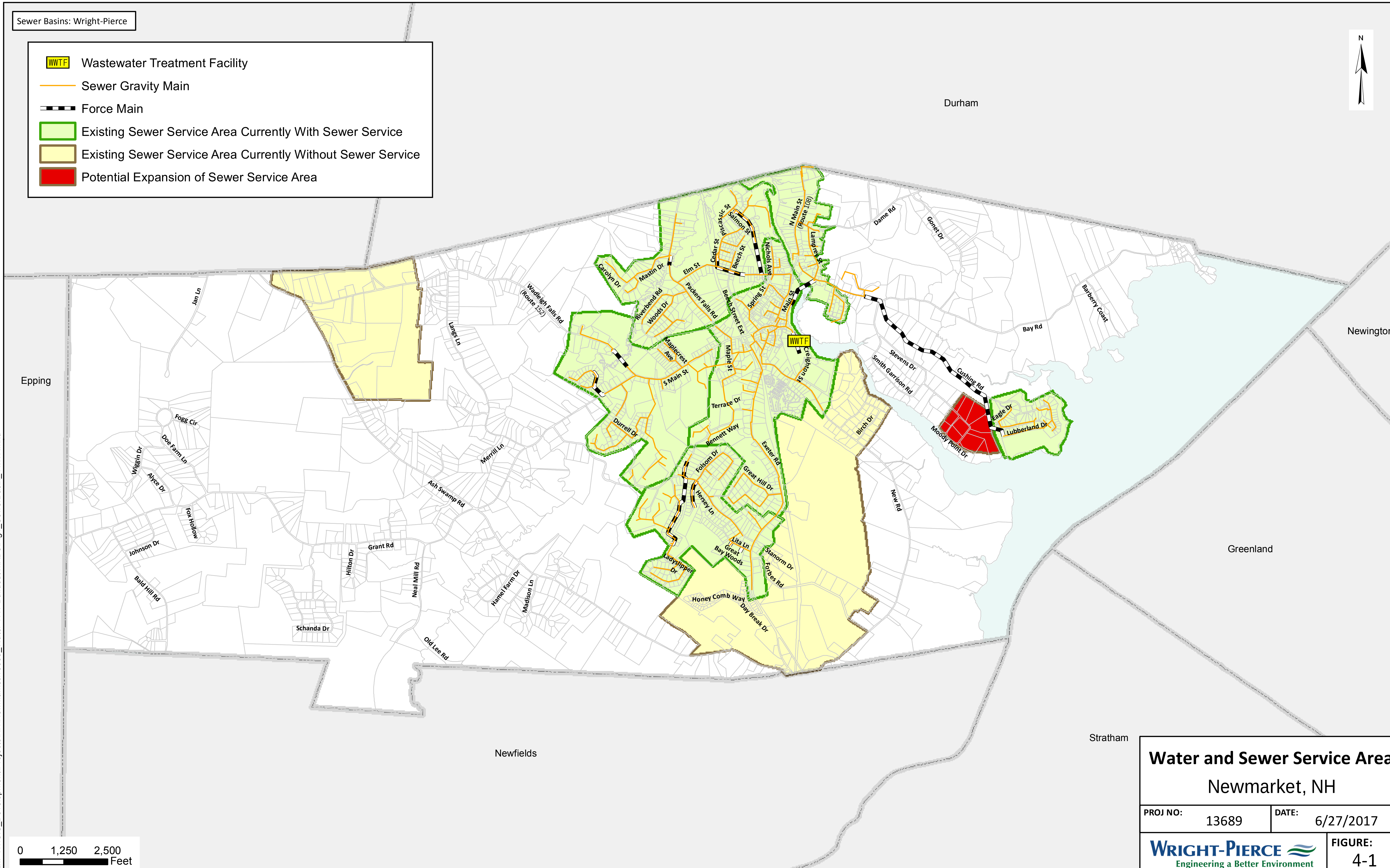
The sewer service area shown in **Figure 4-1** was identified in past studies. Portions of this previously identified service area do not yet have sewer service (shown in yellow on Figure 4-1). The sewer service area includes all potentially densely developed zones. Potential concerns over development in sensitive coastal areas could result in the need to expand the sewer service area to a limited extent as described later in in this section of the report. For purpose of this study we have assumed the service area is expanded slightly, as shown in **Figure 4-1,** to show the Moody Point Drive service area expansion. Also, for this study, it has been assumed that the water service area will be the same as the sewer service area.

4.3 ZONING CHANGES SINCE 2011

A meeting was held March 6, 2017 with the Town of Newmarket Planning Department to discuss the relevancy of past report data, zoning changes since the last build-out analysis in 2011, potential future changes to the Town's zoning, unconstructed but approved developments, and growth within the Town. This information has been incorporated into this study.

The latest build-out study was performed by Underwood Engineers, Inc. of Portsmouth, NH in 2011. Through discussion with the Town's Planning Department and review of the Town's zoning regulations, updates to the Town's zoning laws since 2011 have been determined. Zoning changes, relevant to this study since 2011 are limited to the creation of a new M-2A district which allows mixed use development by special permit in the new M-2A district adjacent to the downtown village area, adopted August 2013. Our analysis looks at the impact of these zoning changes have on water demand and wastewater flows.

The purpose of the M-2A district, per zoning regulations, is to “protect, enhance, and expand commercial, social, civic and residential functions of the downtown village area.” It is intended to be a mixed-use district with an emphasis on commercial and civic development. In this district multi-family residential development (three units or more) is allowed if a special use permit can be obtained from the Planning Board. For this study, we have classified M-2A as a commercial district.



Water and Sewer Service Area

Newmarket, NH

PROJ NO: 13689	DATE: 6/27/2017
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 4-1

4.4 CURRENT ZONING DISTRICT INFORMATION

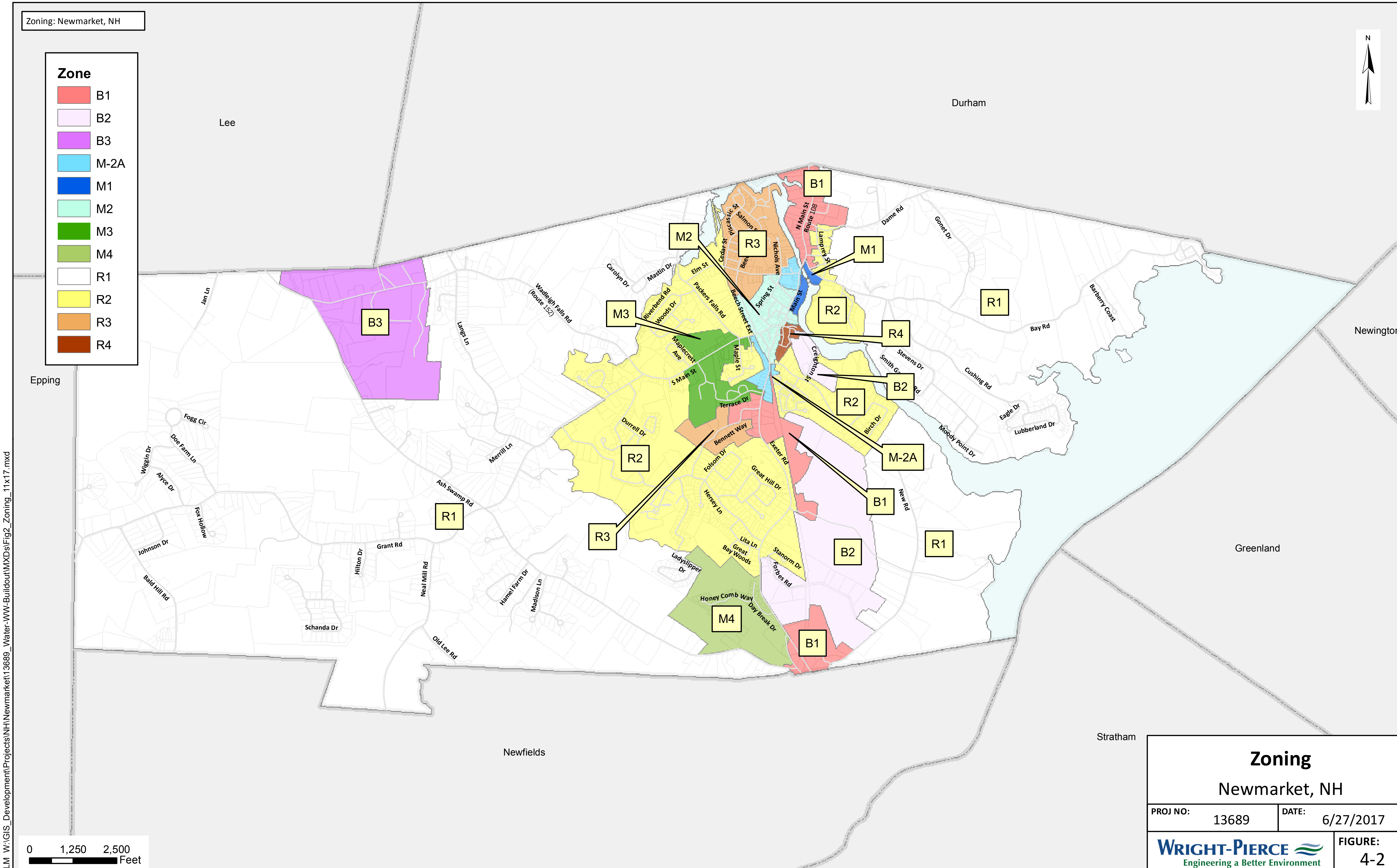
The Town is currently divided into 12 zoning districts as shown on **Figure 4-2**. Each zoning districts has its own regulations for development. Descriptions of each district's intended development can be found in the Town's Master Plan. In general, R districts are for residential development, B districts are for commercial or industrial development, and M districts are for mixed residential/commercial development.

For this analysis, zoning districts were assigned a classification of either residential, commercial, or industrial based on what their predominant current use is, per the Planning Department, and current zoning description indicated in the Master Plan. Using these classifications and the average flows discussed earlier in this study, a gallon per day (gpd) water demand and wastewater discharge per unit, and per buildable acre based on 2016 existing conditions, was assigned to each district as displayed in **Table 4-2**.

TABLE 4-1
ESTIMATED WATER AND SEWER USE
PER UNIT PER ZONING DISTRICT

Min. Lot Size (Acres)	Zoning District	Typical User Class	Estimated Water Demand		Estimated Discharge to Sewer	
			GPD/Unit	GPD/Acre	GPD/Unit	GPD/Acre
2	R1	Residential	105	53	95	48
1/2	R2	Residential	105	210	95	190
1/2	R3	Residential	162	324	145	290
1/4	R4	Residential	105	420	95	380
1/2	B1	Commercial	162	324	145	290
1	B2	Industrial	*	*	*	*
2	B3	Industrial	*	*	*	*
1/4	M1	Commercial	162	648	145	580
1/4	M2	Commercial	162	648	145	580
1/4	M2A	Commercial	162	648	145	580
1/2	M3	Commercial	162	324	145	290
1	M4	Commercial	162	162	145	145

**Currently these Zoning Districts not developed for Industrial Uses. The area do have some "marginal business uses such as gravel pits, agricultural, storage facilities, etc.*



Zoning: Newmarket, NH
Zone
B1
B2
B3
M-2A
M1
M2
M3
M4
R1
R2
R3
R4
Lee
Durham
Epping
Newington
Greenland
Stratham
Newfields
Wadleigh Falls Rd (Route 152)
N Main St Route 108
Main St
S Main St
Exeter Rd
Bay Rd
New Rd
Cushing Rd
Moody Point Dr
Ash Swamp Rd
Grant Rd
Johnson Dr
Schanda Dr
Old Lee Rd
Honey Comb Way
Day Break Dr
0 1,250 2,500 Feet
N
Zoning
Newmarket, NH
PROJ NO: 13689
DATE: 6/27/2017
WRIGHT-PIERCE
Engineering a Better Environment
FIGURE: 4-2
CLM W:\GIS_Development\Projects\NH\Newmarket\13689_Water-WW-Buildout\MXDs\Fig2_Zoning_11x17.mxd

4.5 UNCONSTRUCTED APPROVED DEVELOPMENTS

There are existing permits for the construction of new units which have been approved, but not yet constructed. These have been tabulated below in **Table 4-2**. Several of these permits have been approved for years with no construction, while others have been partially constructed in phased development. **Table 4-2** estimates the total water demand and wastewater discharge anticipated should unconstructed approved units be built and occupied.

TABLE 4-2

APPROVED UNCONSTRUCTED DEVELOPMENTS

Location	Proposed Unconstructed Units	Description	Estimated Average Water Demand (GPD)	Estimated Sewer Discharge (GPD)
Bennett Way	132 units, ~73% completed, 36 units unconstructed	Residential	3,780	3,420
Durell Woods	192 units, ~61% completed, 75 units unconstructed	Residential	7,875	7,125
Selectwood Property	15 units	Residential	1,575	1,418
Golf Course Residential	51 units, ~65% completed, 18 units unconstructed	Residential	1,890	1,710
Hayden Place	10 units, ~60% completed, 4 units unconstructed	Residential	420	380
Boulder Brook Subdivision	11 units	Residential	1,155	1,040
Newmarket Industrial Park	3 buildings (sit on 9 acres of Land)	Industrial	1,238	1,125
M2A zone development	10 units/1 commercial	Mixed Use	1,212	1,090
Grape Street Townhouse	4 units	residential	420	380

Future buildings in Industrial Zoned Areas B-2 and B-3, are assumed to meet the minimum lot size criteria of 1 acre and 2 acres, respectively. Unconstructed, but approved developments noted in **Table 4-2** are assumed to be fully constructed by 2037. These developments are assumed to be constructed by 2037 in the build-out scenario and in all change scenarios as well.

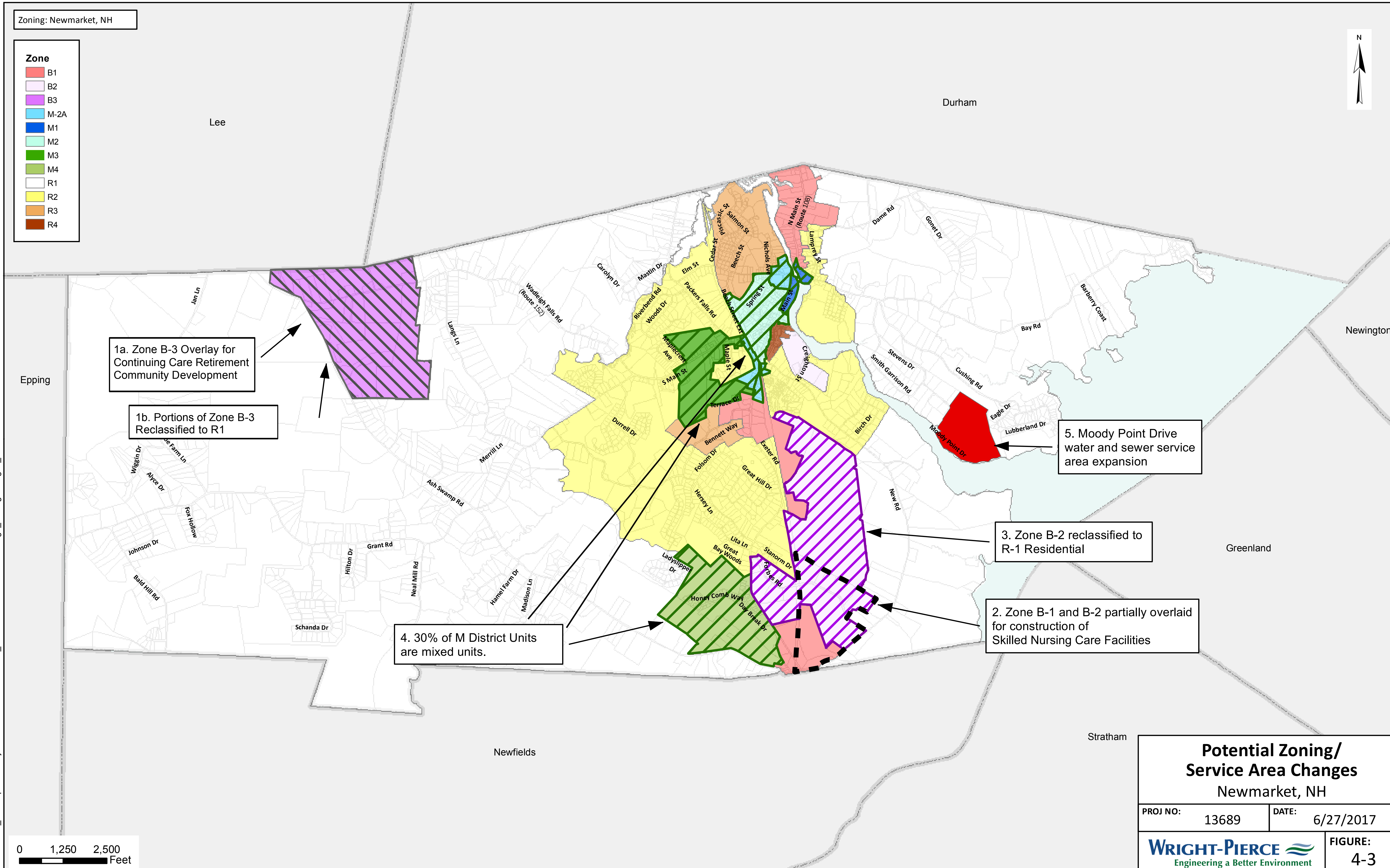
4.6 POTENTIAL ZONING AND DEVELOPMENT CHANGES AND POSSIBLE UTILITY EXTENSIONS

Potential zoning changes shown in **Figure 4-3** have been summarized from information gathered during our meetings with the Planning Department and the "Future Land Use" section of the Town of Newmarket Master Plan adopted 7/12/2016. In this study, we have included areas of development which might require sewer and water service over the next twenty years, but have not yet been proposed or re-zoned. The following potential zoning or development changes would impact this build-out study. Therefore, the impacts on water source capacity and wastewater treatment plant capacity have been considered. Note that it is beyond the scope of this study to determine the capital improvements that may be required to provide sewer and water service in these areas of potential rezoning. All significant new development would require a engineering feasibility study to determine the sizing and costs of capital improvements required to provide water and wastewater service to accommodate the development.

- **POTENTIAL CHANGE 1a –** In Zoning District B-3, off Route 152, an overlay district allowing for a Continuing Care Retirement Community (CCRC) development by special use permit is proposed. We understand the number of units which could result from development of CCRC's in this area would be a maximum of 250 units. It is assumed that these units would generate water and sewer demands comparable to a residential unit.

  Under this Potential Change 1a we have assumed the 250 CCRC units will use 100 acres of the 214 acres of buildable land within this B-3 zone. Therefore, 114 acres could still be available for industrial and business development.

  This district is near the Bennett and Sewall Wells, which allows for easy access to water service. For this development to occur, sewer service would need to be extended along Route 152 from the current sewer system approximately 5,000 feet to the B-3 district. At least one additional pump station and an existing pump station upgrade may be needed to extend sewer service to this area.



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Extending sewer to this B-3 Zone may open sewer service to some homes and businesses along Route 152. It is assumed that these units will contribute a small amount to the sewer discharge in comparison to the proposed 250 units and industrial/business development within the B-3 zone. Therefore, additional units outside the B-3 district have not been accounted for in this scenario. If this development were pursued, further analysis is recommended for the existing and proposed sewer infrastructure, possible contributing residential flows.

- **POTENTIAL CHANGE 1b –** Potential Change 1b is a variation of potential Change 1a (CCRC Overlay) except the remaining B-3 zone will be rezoned as a residential area (R-1) after the CCRC overlay area is built-out. This potential change significantly reduces the future water demand and wastewater flow from this area.

- **POTENTIAL CHANGE 2 –** An overlay district allowing for construction of skilled nursing care facilities is proposed over a portion of District B-2 and the entire B-1 district east of the railroad tracks. Developments would be by special use permit, limited in size and impacts due to access and environmental concerns. For this study, we have assumed the density will be the same as that of District M-2 at 6 units per acre. Essentially, the change takes 45 acres of buildable land zoned B-1 and B-2 and converts it into 45 acres of land which could have up to 270 units by zoning criteria. For our study, we have assumed there could be potentially 180 units to consider green space, parking roads etc. For this development to occur, additional water and sewer service would need to be extended into B-1 and B-2.

- **POTENTIAL CHANGE 3 –** Strategies to limit future water/sewer demand in the B-2 Zone to the existing average industrial park demand. In the “as zoned” build-out scenario (Scenario #1) it has been assumed that new industrial development in the B-2 zone will have an average water demand of 825 gpd per acre (and an average sewer demand of 750 gpd/acre). If the Town limited the per-acre industrial demand by zoning changes or other means, the projected future water and sewer demand associated with the undeveloped industrial land would be reduced by approximately 58%. While the 825 gpd per acre water demand allowance is a common text book allowance for industrial development with moderate water use, this is significantly more than the current industrial park average of 324 gpd per acre.

- **POTENTIAL CHANGE 4 –** The allowance of mixed use development in the M districts by special use permit may continue to add multiple units per commercial unit for the M1, M2, M2A, M3, and M4 zoning districts. This analysis assumed a scenario where 30% of all units in the M districts are mix units and have flow rates as determined in the build-out analysis sections of this study.

- **POTENTIAL CHANGE 5 –** The Future Land Use Plan included a section on climate change and the protection of environmental and coastal resources. These are important goals given the water quality challenges facing Great Bay. The goals of this plan may result in the desire to extend water and/or sewer to a few additional areas.

  The "Moody Point Development" along the Eagle Drive area, is a primary example of a dense community constructed close to coastal resources. "Moody Point Development" has its own pump station which allows sewage to be discharged away from the community and treated by the Town's WWTP. If further coastal development or tighter environmental restrictions limit the use of septic systems and private well water use in areas such as this, other residential areas in this vicinity may need to tie into the Town's sewer collection system in the future. To account for this possibility, the sewer and water service area is expanded slightly as shown on **Figure 4-1**.

SECTION 5

Build-Out Analysis

SECTION 5

BUILD-OUT ANALYSIS

5.1 INTRODUCTION

The Build-Out Analysis is used to project future water demand and wastewater flows. Typically, the Build-Out Analysis is based on a twenty-year planning period. For this analysis, 2037 is the end of the planning period. Our analysis also looked at a full (saturation) build-out based on current zoning, and based on potential future zoning and development changes within the water and sewer service area. For this analysis, we looked at a future water and wastewater demands in a variety of ways including:

1. Twenty-year Build-Out (2037) of the water and sewer service areas based on population projections.
2. Saturation Build-Out of the water and sewer service areas using current zoning.
3. Impacts of the potential zoning or development changes, discussed in Section 4, on the above projections.

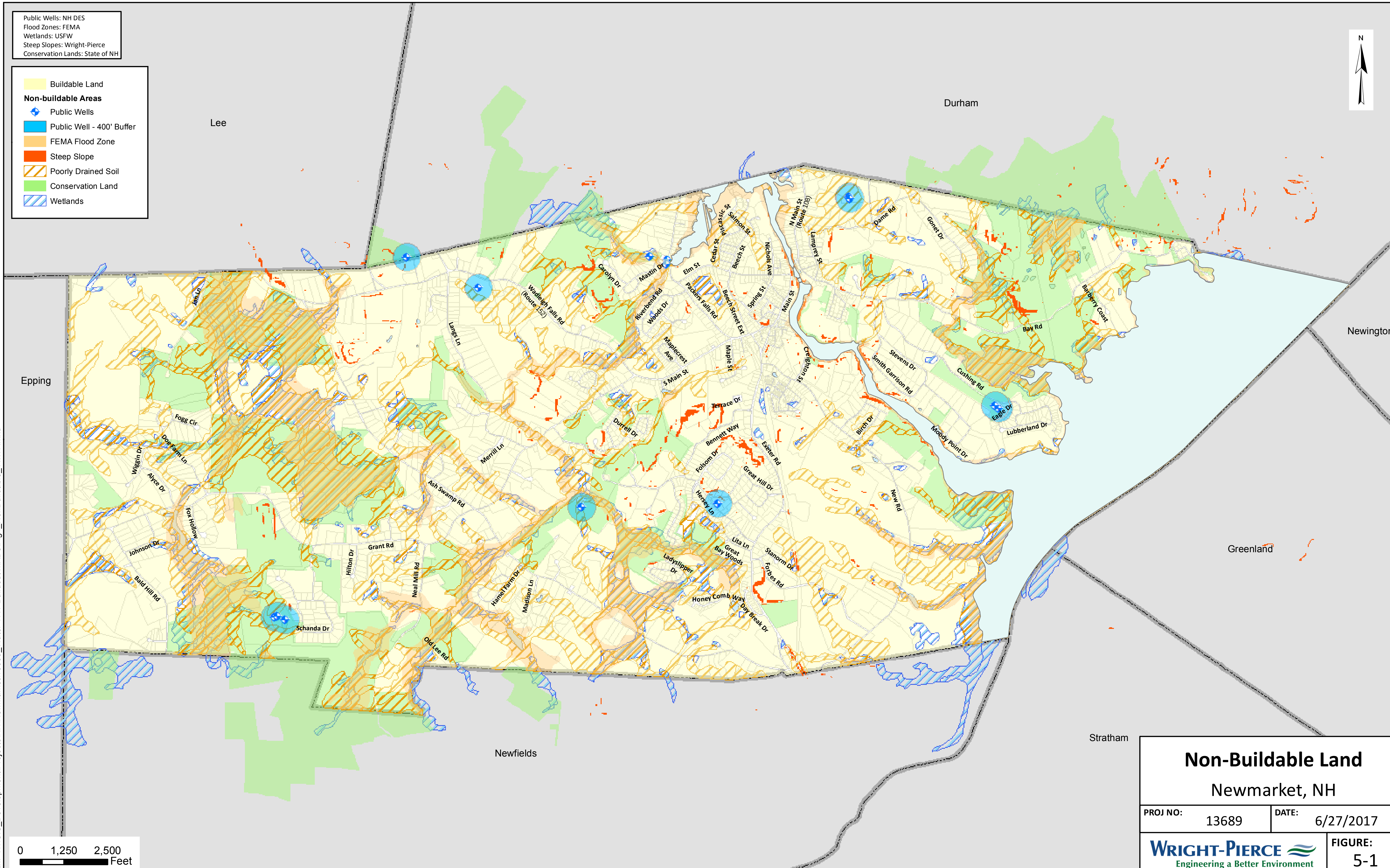
5.2 CURRENT REMAINING BUILDABLE AREA

For the Saturation Build-Out analysis we need to know how much remaining buildable area is available. Buildable area per zoning district was determined using GIS data and tools to eliminate certain areas of land based on selected criteria. 100% of the following areas were assumed to be ineligible for development as shown on **Figure 5-1**:

- Mapped wetland areas
- Wetland buffer zones
- 100-year flood zone
- Conservation lands
- Poorly Drained Soils
- Steep Sloping Land

In buildable areas, it is assumed that area will be needed for roads, utilities, and rights-of-way as the community develops. The buildable area has been reduced by 10% to account for this construction.

Buildable area was further reduced by using assessing data to eliminate lots which have already been fully developed. Lots with development exceeding current zoning regulations or having less than the allowable buildable area remaining for the construction of a minimum of one new unit per zoning regulations, were not included in the current net buildable area. Current zoning criteria for development per district is shown in **Table 5-1**. **Table 5-2** summarizes net buildable area within the water and sewer service area (water and sewer service area shown in Figure 4-1).



Non-Buildable Land

Newmarket, NH

PROJ NO: 13689	DATE: 6/27/2017
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 5-1

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TABLE 5-1
2016 ZONING DEVELOPMENT CRITERIA

Requirement	Unit	M-1	M-2	M-2A	M-3	M-4	B-1	B-2	B-3	R-1	R-2	R-3	R-4
Minimum Road Frontage	feet	75	50	50	75	150	150	150	150	200	100	100	50
Minimum Lot Size	acres	¼	¼	¼	½	1	½	1	2	2	½	½	¼
Maximum Residential Density	units/ acre	20	6	6	2	1	2	1	-	½	2	2	4
Minimum Road Setback	feet	10	5	5	20	20	15	25	75	40	25	25	5
Maximum Road Setback	feet	n/a	10	10	50	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minimum Side/Rear Setback	feet	10	10	10	20	25	25	30	20*	25	15	15	10

TABLE 5-2
BUILDABLE AREAWITHIN THE WATER AND SEWER SERVICE AREA

Zoning District	Gross Area (acres)	Net Buildable Area (acres)
R1	315	187
R2	633	456
R3	133	95
R4	8	8
B1	157	117
B2	333	241
B3	264	214
M1	8	6
M2	43	41
M2A	19	18
M3	28	27
M4	106	63
Total	2047	1473

5.3 ESTIMATED POPULATION GROWTH

This analysis relies on the U.S. Census Bureau and the New Hampshire Office of Energy and Planning's (OEP) projected data for population growth in the Town. The population of the Town of Newmarket was estimated at 8,936 in the 2010 U.S. Census. The 2016 OEP report gives an estimate of future population growth in five year increments. For a 20-year projection from the date of this study, population projections were considered from 2015 to 2040. On average, the Town of Newmarket is projected to grow at a rate of 0.05% to 0.78% per year per OEP.

TABLE 5-3
OEP POPULATION PROJECTION DATA ANALYSIS

Year	*2010	2015	2020	2025	2030	2035	2040	Average
Projected Population	8,936	9,170	9,505	9,877	10,097	10,224	10,248	
% increase over 5 years		2.62	3.65	3.91	2.23	1.26	0.23	0.46
% increase per year		0.52	0.73	0.78	0.45	0.25	0.05	0.46

* 2010 census data

This growth has been graphed in **Figure 5-1** to show that peak growth is anticipated between 2015 and 2030, with declining growth from 2030 to 2040 and beyond. On average, the OEP projected growth is 0.46% per year from 2015 to 2040. The previous 2011 build-out study, assumed a growth rate of 0.81% per year. To be conservative, this study has averaged these two growth rates to project a future growth rate of **0.64%** per year.

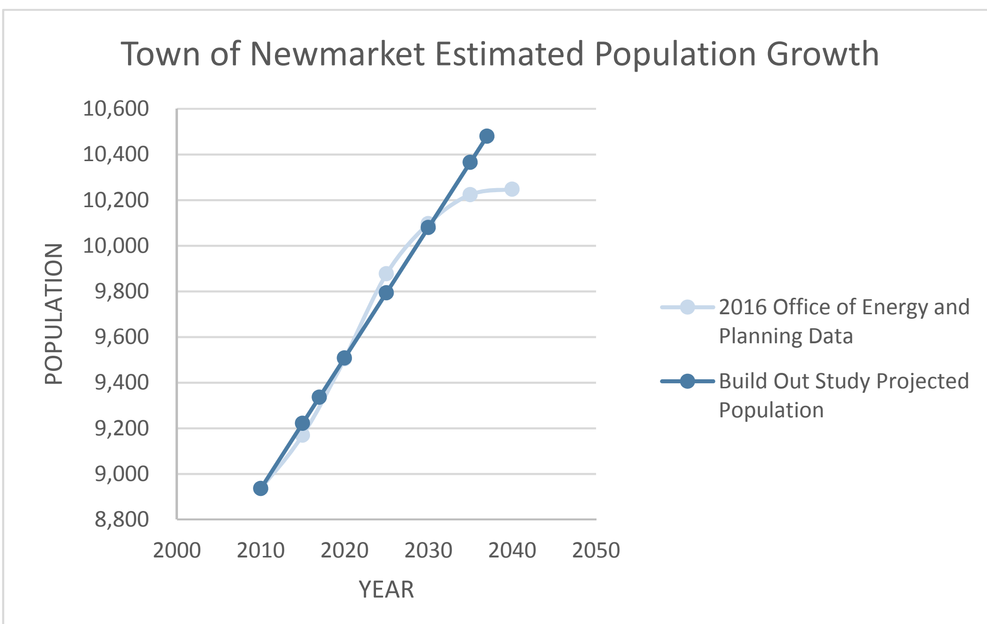
It is assumed that the last actual count of Newmarket's population was performed during the 2010 census. Past studies have determined that past OEP population projections tend to be slightly lower than actual growth. Newmarket's 2010 population was 8,936. Straight line growth at a rate of 0.64% from 2010 to 2037 yields an estimated 2017 population of approximately 9,336 residents and an estimated 2037 population of approximately 10,480. This is an increase of approximately 1,144 residents from the estimated 2017 population. Projected population based on the 0.64% per year growth rate is shown in **Table 5-4** below.

TABLE 5-4
BUILD OUT STUDY PROJECTED POPULATION

Year	*2010	2015	2017	2020	2025	2030	2035	2037
Projected Population	8,936	9,222	9,336	9,508	9,794	10,080	10,366	10,480

*2010 census data

FIGURE 5-2

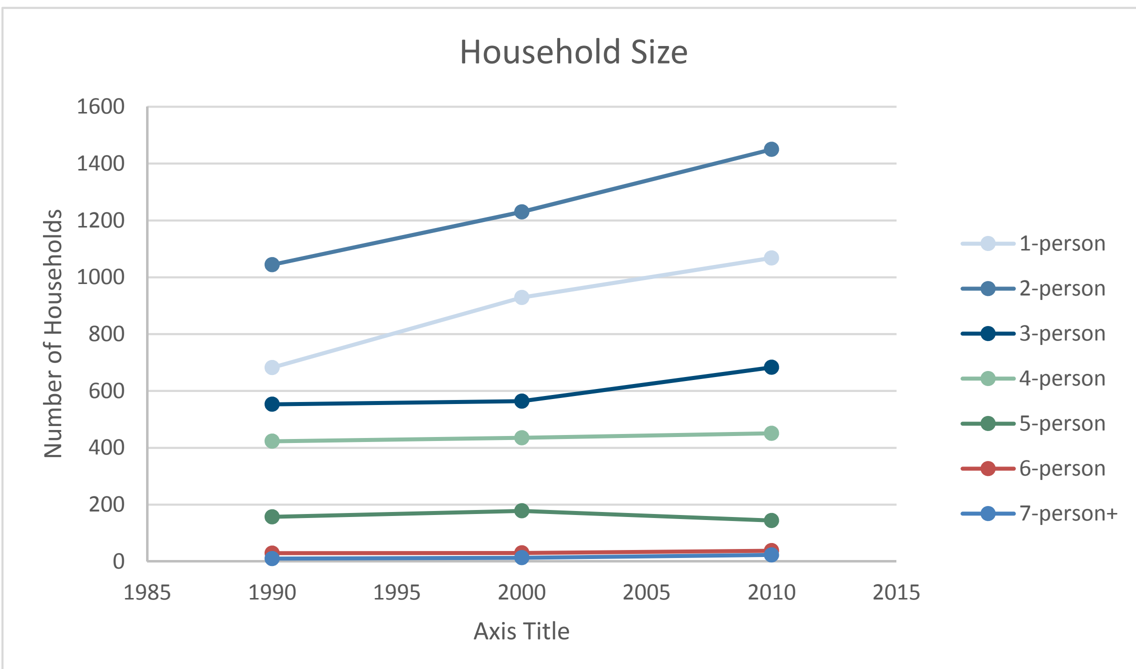


According to the household demographic section of the Newmarket Master Plan, household size on average has been decreasing. Household size data has been summarized in **Table 5-5** and in **Figure 5-4**. The trend in household size between 2000 and 2010 indicates that there is far greater growth in 1 to 3 person households, with the greatest increase in 2 person households.

TABLE 5-5
TOWN OF NEWMARKET HOUSEHOLD SIZE

Year	1 person	2 person	3 person	4 person	5 person	6 person	7 person+	Total	Weighted Average
2010	1068	1450	683	451	144	38	23	3857	2.32
2000	929	1230	564	435	178	30	13	3379	2.36
1990	682	1044	553	423	157	29	10	2898	2.47
Source: U.S. Census Bureau/Newmarket Master Plan									

FIGURE 5-3



Based on household trends, this study assumes, for purposes of estimating new residential units, that future units will average 2.3 person households. Dividing the projected population growth by

2.3 people per newly constructed unit, approximately 497 residential units are anticipated to be constructed by 2037 to accommodate growth.

5.4 2037 BUILD-OUT ASSUMPTIONS

For this analysis, zoning districts were assigned one of the following classifications based on what their predominant current use and current zoning descriptions indicated.

- Residential
- Commercial
- Industrial

Average water demand and sewer discharge per unit for these zone classifications was estimated in Section 3 of this study. **Table 4-1** listed each zoning district with its corresponding current classification and equivalent estimated flow per unit. Applying the previously calculated values for water demand and sewer discharge per residential unit to the estimated number of units to be constructed within twenty years (497), it is estimated that there will be an increase of approximately 52,185 gpd in water demand and approximately 47,220 gpd in sewer discharge. The residential sewer demand is projected to increase by 56,715 gpd due to the 497 new residential units plus 100 units of existing housing in sensitive coastal areas not currently on the sewer system, but could be by 2037.

The 2011 build-out study estimated future commercial and industrial water/sewer demands would increase in direct relation to the increase in population. This study used the same method. For 2037 planning purposes, we have also assumed the Continuing Care Retirement Community (CCRC) will be constructed in Zoning District B-3 off Route 152 (250 units) and in Zoning District B-2 off New Road (75 units). The 2037 sewer flow projections also include an allowance of 50,000 gpd for wastewater discharge from the possible future water treatment plant from the MacIntosh and Tucker Wells.

5.5 EFFECT OF APPROVED UNCONSTRUCTED DEVELOPMENTS

All approved unconstructed developments, discussed in Section 4, are anticipated to be completed by 2037.

5.6 BUILD-OUT PER POPULATION GROWTH

The 2011 build-out study noted that existing sewered areas are already built out under current zoning regulations. Early developments in the Town are most often “grandfathered” and exempt from meeting certain zoning regulations applied to new development. This has allowed for denser development in certain areas than is allowable by current zoning. Many of these existing areas are considered to have more units within the zoning district than allowable per regulations; however, this analysis has not considered whole areas as built-out. The analysis for determining water demand and sewer flow, based on population growth, does not consider where the growth will occur. The analysis assumes that growth will be accommodated within water and sewer service area.

TABLE 5-6
PROJECTED 2037 WATER DEMAND BASED ON POPULATION GROWTH

Year- 2037	2017 Estimate (gpd)	Added Units	Added Flow (gpd)	Estimated Average Day Flow (gpd)	Estimated Max Day	
					Peaking Factor	Max Day (gpd)
Residential	306,850	497	52,185	359,035	1.8	646,260
CCRC	-	325	34,125	34,125	1.8	61,425
Commercial	29,750	31	5,060	34,810	1.8	62,660
Industrial	15,630	8	2,660	18,290	1.8	32,920
Sub-total	352,230		94,030	446,260		803,270
Water Loss (15%)	52,830	-	14,100	66,930	1.8	120,470
Total	405,060	-	108,130	513,190	1.8	923,740

TABLE 5-7
PROJECTED 2037 SEWER FLOWS BASED ON POPULATION GROWTH

Year- 2037	2017 Estimate (gpd)	Added Units	Added Flow (gpd)	2037 Estimated Average Day Flow (gpd)	2037 Max Day Flow (gpd)	2037 Peak on Max Day (gpd)
Residential	276,170	597	56,715	332,890	932,090	1,997,340
CCRC	-	325	30,880	30,880	86,460	185,280
Commercial	26,775	31	4,550	31,325	87,710	187,950
Industrial	14,070	8	2,390	16,460	46,090	98,760
Sub-Total	317,010		94,535	411,550	1,152,330	2,469,330
I/I Per Day[1]	264,000		28,360	292,360	584,720	877,080
WTP Discharge	-	-	50,000	50,000	50,000	50,000
Total	581,010		172,895	753,920	1,787,050	3,396,410

Note:
1. I/I value calculated as existing baseline I/I (264,000 gpd) + 30% of additional sewage flows.

5.7 SATURATION BUILD-OUT

GIS data and software were used to apply select criteria and evaluate current assessing data to determine the maximum number of units that could be constructed in the net buildable area per current zoning regulations within sewer and water service area. Individual lots were considered within zoning districts and sewer sub-basins.

The saturation build-out assumes that all buildable land within the defined sewer service area will be developed with the maximum number of units per zoning regulations. Additional unit development, possibly with special use permits, has not been considered. The saturation build-out is intended to estimate how many units could potentially be constructed within the defined sewer sub-basins and what the estimated total water and wastewater system demands might be. Water demand and sewer discharge factors are applied to each buildable unit based on the zoning district classification and the flows per zoning district classification estimated earlier in this study.

It should be noted that the saturation build-out analysis is generally a hypothetical value that can show how zoning may impact water and sewer demands. The Town of Newmarket has the most buildable land in areas presently zoned as Industrial (B-2 and B-3); therefore, the saturation build-out predicts most of the demand to come from these areas. Using the standard of 825 gpd per buildable acre and 750 gpd per buildable acre for future water and sewer predicts high demands and significant industrial growth. Based on history, this type of growth has not occurred in Newmarket.

TABLE 5-8
PROJECTED SATURATION BUILD-OUT WATER DEMAND

	Units	Estimated Average Day Flow (gpd)	Estimated Max Day	
			Peaking Factor	Max Day (gpd)
Residential	3708	389,340	1.80	700,812
Commercial	696	112,752	1.80	202,954
Industrial	-	388,980[1]	1.80	700,160
Water Loss (15%)		131,620	1.80	236,916
Total		1,022,692	1.80	1,840,842

Note:
1. Value based on buildable land at 825 gpd/acre, plus existing flows.

TABLE 5-9
PROJECTED SATURATION BUILD-OUT SEWER FLOWS

	Estimated Units	Estimated Average Day Flow (gpd)	Max Day Flow (gpd)	Peak on Max Day (gpd)
Residential	3633	343,320	823,964	1,373,274
Commercial	660	96,228	230,947	384,912
Industrial	-	350,082[1]	840,197	1,400,328
I/I Per Day[1]		405,786[2]	811,573	1,217,359
Total		1,195,415	2,706,681	4,375,873

Note:
1. Value based on buildable land at 750 gpd/acre, plus existing flows.
2. I/I value calculated as existing baseline I/I (264,000 gpd) + 30% of additional sewage flows.

A key difference between the 2037 water demand and sewer flow projections and the saturation build-out projections is the 2037 figures are based on twenty-year population growth without consideration of where that growth occurs. The saturation build-out projections look at each lot within sewer and water service area and calculates the build-out potential of each lot based on current zoning. When comparing population build-out numbers versus saturation build-out numbers, it shows more people will be living in mixed-use zones within the commercial zone. To be noted with current zoning saturation, build-out shows significant increases in water demand and sewer flow within the industrial zoned areas.

5.8 POTENTIAL BUILD-OUT CHANGE SCENARIOS

Potential zoning and development changes being considered by the Town are described in Section 4. **Table 5-10** shows the impact these changes have on water demand and wastewater flows. The full impact of these zoning and development changes should be applied to average day estimated saturation build-out numbers in **Tables 5-8** and **5-9**. **Table 5-11** shows the combined impact of two (2) combinations of zoning/service area changes to the saturation build-out demand.

As discussed in Section 6, the wastewater treatment plant discharge permit limit of 0.85 mgd is a significant constraint. The good news is that the 20-year projections are below this permitted capacity. Ideally, the projected sewer flows from the sewer service area would also be below this permit limit under saturation build-out conditions. As can be seen in **Table 5-9**, it is projected that the theoretical full build-out of the sewer service area as currently zoned would exceed the existing permit limit by 378,700 gpd. This exceedance is largely due to the assumptions about future flow from industrial zones (B-2 and B-3) contributing significant water and sewer demand at full build-out. The potential future zoning and development scenarios significantly lower the saturation build-out demands as illustrated in **Table 5-11**. For this reason, these potential future zoning and development changes would be advisable. These potential zoning and development changes would also have a meaningful impact on water demands.

TABLE 5-10

EFFECT OF CHANGE SCENARIOS ON SATURATION BUILD-OUT

Scenario		Water (gpd)		Sewer (gpd)
		Average	Max./Day	Average
#1	As Zoned	1,022,692	1,840,842	1,195,415
#2	Changes 1a, 2, 3, 4, 5	852,690	1,534,850	996,500
#3	Changes 1b, 2, 3, 4, 5	764,620	1,376,310	893,465

TABLE 5-11

IMPACTS OF ZONING/DEVELOPMENT CHANGES ON SATURATION BUILD-OUT

Change Number	Description	Estimated Water Demand Change Compared to Present Zoning (gpd)	Estimated Sewer Discharge Change Compared to Present Zoning (gpd)
1a	Zone B3 is overlaid for CCRC development, remainder zoned industrial	(56,250)	(65,820)
1b	Zone B3 reclassified to R-1 residential from industrial. Includes CCRC Overlay	(144,315)	(168,850)
2	Zone B-2 partially overlaid and B-1 entirely overlaid east of the railroad tracks for construction of skilled nursing care facilities classified as M-2 residential	2,556	2,990
3	Zone B-2 limits future demand per acre to historical industrial average	(114,716)	(134,220)
4	30% of existing M district units are approved as mixed units	(2,858)	(3,340)
5	Additional Moody Point area with public water and sewer	1,260	1,474
Scenario #1	Total 1a, 2,3,4 and 5	(170,000)	(198,910)
Scenario #2	Total 1b, 2,3,4 and 5	(258,073)	(301,950)

SECTION 6

Wastewater Treatment Facility

SECTION 6

WASTEWATER TREATMENT FACILITY

6.1 DISCHARGE PERMIT

The wastewater treatment facility (WWTF) is licensed by the Environmental Protection Agency (EPA) under a National Pollutants Discharge Elimination System (NPDES) Permit to discharge into the Lamprey River. The EPA issued a new discharge permit to the Town in the fall of 2012 with stringent total nitrogen (TN) limits (< 3mg/l). The Town negotiated an Administrative Order by Consent (AOC) with the EPA that requires achieving a TN limit of < 8 mg/L within 5 years. These standards establish minimum effluent discharge requirements which must be satisfied at all times. Based on the Town's current National Pollutant Discharge Elimination System (NPDES) permit (NH0100196) was issued in November 2012 and became effective on April 1, 2013 and expires on April 1, 2018. **Table 6-1** below provides the WWTF effluent discharge limits.

TABLE 6-1
NPDES FINAL PERMIT EFFLUENT LIMITS

PARAMETER	MONTHLY AVERAGE	WEEKLY AVERAGE	DAILY MAXIMUM
Flow, mgd	0.85	–	Report
BOD5, mg/L (lb/d)	30 (213)	40 (319)	50 (354)
TSS, mg/L (lb/d)	30 (213)	45 (319)	50 (354)
Total Nitrogen, mg/L (lb/d)(1)	3.0 (21)	–	Report

(1) Interim Total Nitrogen (TKN + nitrate + nitrite) limit set in AOC is 8.0 mg/L – calculated on a 214-day seasonal rolling average.

The current NPDES Permit contains a maximum monthly flow limit of 0.85 million gallons per day (mgd). This is inconsistent with the Town's intent to obtain a permit with an annual average flow of 0.85 mgd. Currently the Town receives monthly flows as high as 1.05 mgd (99th percentile). The current monthly flow limit presents a major issue for the Town's ongoing compliance and future allowable growth. Preliminary discussions began with the EPA back in 2014 to modify the permit limit to an "annual average" flow rate and revise to a reporting requirement only, consistent with other NPDES Permits within the Region (i.e. Great Bay). However, this permit revision was never finalized. Though it is hopeful the permit will be changed, it is not guaranteed. If the permit is not changed from a maximum monthly flow limit to an annual average flow limit, the Town will not be able to allow the projected sewered growth to occur unless an equal corresponding reduction in I/I is accomplished. Even if the permit is modified to include an annual average flow limit of 0.85 mgd, the Town should closely track the growth to make sure it is consistent with growth projections. For this evaluation, it is assumed that the Town will continue discussions with EPA that will result in successful modification of their WWTF permit to a 0.85 mgd annual rolling average flow rate, potentially as a reporting only requirement.

6.2 EXISTING FLOWS & LOADS

6.2.1 Existing Flows

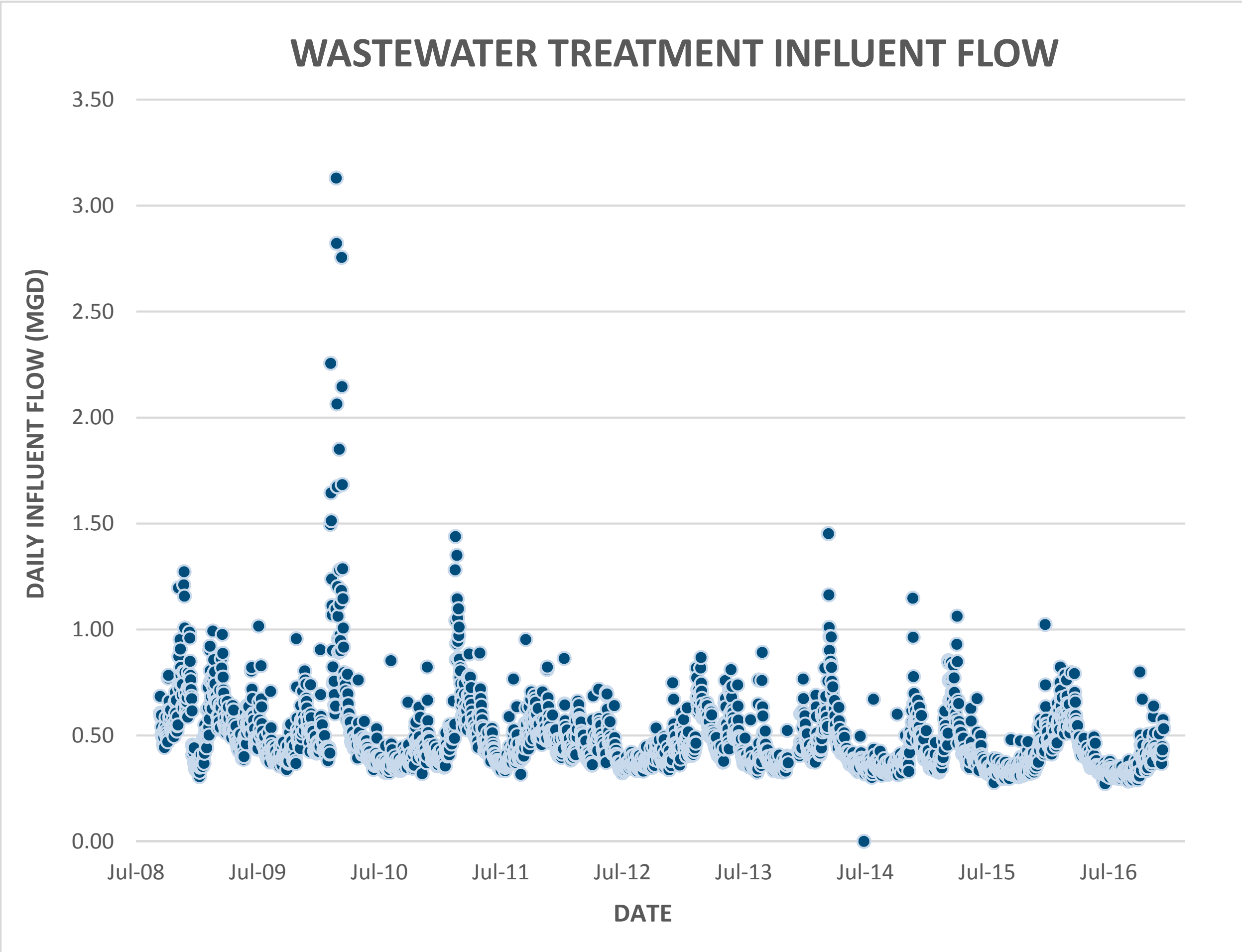
WWTF influent flows conveyed to the WWTF are monitored and recorded by a magnetic flow meter at the influent pump station and an effluent parshall flume at the WWTF. For this evaluation, the influent magnetic flow meter data was used for analysis due to internal recycle flows in the WWTF which may misrepresent actual influent flow data. Flow data for the past 8 years of influent flow data (2008-2016) are been summarized in **Table 6-2** and **Figure 6-1** below.

Table 6-2: INFLUENT WWTF FLOW

Year	Totalized Influent Wastewater [1] (gal/yr)	Average Day (GPD)
2008	237,531,500	650,771
2009	188,224,700	515,684
2010	161,218,000	441,693
2011	188,739,300	517,094
2012	158,737,000	434,896
2013	168,652,000	462,060
2014	147,917,000	405,252
2015	151,494,000	415,052
2016	151,110,000	414,000

Note: [1]Totalized influent data provided by the Town. WWTF effluent data in some cases presents slightly different values, however, the difference (+/- 3%) is considered negiligible.

FIGURE 6-1



The total volume of wastewater influent received at the WWTF varies annually, but has shown a gradual continual decrease since 2008. The decrease is influent flow to the Facility can be attributed to a variety of factors including:

- Low pipe infiltration rates (e.g. low groundwater tables) due to regional drought conditions
- Reductions in I/I throughout the collection system through inflow source removal, sewer repair and replacement projects, and manhole rehabilitation
- Town-wide water bans restricting general outdoor water use based on water supply shortages
- Residential water use decline due to increases in sewer rates
- Continued residential upgrades with “low-flow” spigots, faucets, showerheads, toilets, etc.

6.2.2 Existing Pollutant Loads

Overall, the WWTF pollutant loadings are the key parameters in determining the capacity of the secondary treatment process. Important loading parameters to the secondary process include biological oxygen demand (BOD), total suspended solids (TSS), and total nitrogen (TN). Influent and effluent load characteristics are continuously monitored at the WWTF by composite samplers. The loads to the WWTF are expressed as a mass loading in pounds per day (lbs/day) which accounts for the influent wastewater flow and concentration.

Wastewater load characteristics were evaluated extensively as part of the WWTF Preliminary Design Report (PDR) (Wright-Pierce, May 2014). Review of wastewater loading data since this report do not indicate a significant change in wastewater influent quality since the 2014 PDR and therefore influent loading assumptions used for that report are considered representative for this evaluation. **Table 6-3** below provides key WWTF loading parameters for data compiled from 2008-2016.

TABLE 6-3

EXISTING WWTF INFLUENT LOADS (2008-2016)

PARAMETER	ANNUAL AVERAGE	MAX MONTH[1]
Flow, mgd	0.48	1.04
BOD5, mg/L (lb/d)	253 (1,007)	202 (1,748)
TSS, mg/L (lb/d)	271 (1,079)	264 (2,284)
TKN, mg/L (lb/d)	35 (139)	-
Ammonia-N, mg/L (lb/d)[(1)]	25 (100)	-

Note: Based on 99th percentile of a 30-day rolling average.

6.3 WWTF DESIGN CAPACITY

The total capacity of the WWTF is dictated by the capacity of the secondary treatment system. The secondary treatment system is currently in the process of a comprehensive upgrade to a 4-Stage Bardenpho activated sludge process (May 2017). The purpose of this upgrade is to provide the Town with a secondary treatment process capable of meeting more stringent current and future nitrogen effluent standards. The overall treatment capacity of this process is largely dictated by two factors:

1) Total volume of influent flow to the WWTF, and
2) Total pollutant load to the WWTF

In the case of the WWTF design capacity, we will treat these two factors separately because of how they are regulated within the NPDES permit. Wastewater influent flow is regulated independent of influent parameter (load) concentrations, while influent load is calculated on a total daily mass limit (lbs/day) derived from a combination of flow and concentration. The new WWTF was designed with the following influent wastewater parameters as developed in the Preliminary Design Report (Wright-Pierce, May 2014). Projected design load concentrations are shown in **Table 6-4** use the same load concentrations as shown in **Table 6-3.**

TABLE 6-4

WWTF INFLUENT DESIGN PARAMETERS (2030)

	ANNUAL AVERAGE	MAX MONTH
Flow, mgd	0.85	1.54
BOD5, mg/L (lb/d)	253 (1,794)	202 (2,604)
TSS, mg/L (lb/d)	271 (1,921)	197 (2,530)
TKN, mg/L (lb/d)	35 (248)	30 (385)
Ammonia-N, mg/L (lb/d)(1)	25 (177)	21 (274)

(1) Interim Total Nitrogen (TKN + nitrate + nitrite) limit set in AOC is 8.0 mg/L – calculated on a 214-day seasonal rolling average.

The following sections provide discussion of excess WWTF capacity at existing and projected wastewater flows.

6.3.1 Wastewater Flow Capacity

The Town's current NPDES permit limits average monthly flows to the WWTF to 0.85 mgd, independent of influent load concentrations. For this evaluation, it is assumed that the Town will continue working with EPA to have this flow limit revised to a rolling <u>annual average</u> flow of 0.85

mgd. Under the assumption of this revised permit, the WWTF will be limited to annual average flow of 0.85 mgd. Wastewater flows may be periodically higher, or periodically lower than this 0.85 mgd limitation, but the overall annual average will be required to stay below 0.85 mgd. Using the annual average flowrate of 0.85 mgd as the Town's baseline, **Table 6-5** details the existing and projected wastewater flows to the WWTF, in addition to the remaining WWTF flow capacity at each of these scenarios.

Using the wet year flow estimates developed in **Section 3.3.2**,the Town currently has an estimated excess flow capacity of **0.27 mgd** at the current annual average flowrates (2017). It must be noted that the existing year annual average flowrate used for this evaluation (0.58 mgd) includes a sewage component and an I/I allowance for wet-year conditions and is a conservative estimate.

Using the 2037 Build-out projections from Section 5, the Town will have an estimated excess capacity of approximately **0.17 mgd** in 2037 at the WWTF. The increase flows to the WWTF from existing year (2017) to the 2037 build-out scenario were primarily estimated to be residential in nature with only a small fraction of the flow increases being attributed to commercial or industrial sectors.

Build-out projections assuming full saturation of undeveloped residential and industrial zoned areas indicates that the Town does not currently have enough WWTF capacity at annual average conditions if flow projections hold true (1.20 mgd vs. 0.85 mgd permitted).

TABLE 6-5

CURRENT AND FUTURE WWTF FLOW CAPACITY

CONDITION	WWTF DESIGN (2030)	Existing Year (2017)		Build-Out (2037)		Build-Out Saturation	
		Existing Flow	Remaining Capacity	Projected Flow	Remaining Capacity	Projected Flow	Remaining Capacity
Annual Average (mgd)	0.85	0.58[1]	**0.27**	0.68	**0.17**	*1.20*	*(0.35)*[2]

(1) See Table 3-7 for derivation. Compare to 0.42 mgd (2016 observed WWTF annual average flow) with an allowance for baseline I/I observed previously in the collection system.

(2) Build-out saturation projection indicates that influent sewerage flows would exceed the current flow discharge limit of 0.85 mgd.

Based on this assessment, the Town's current wastewater discharge permit is not large enough to fully realize the flow component associated with a complete build-out saturation as currently zoned. As discussed in Section 5, the Town ideally would prefer to promote growth that would allow build-out saturation within the Town's existing wastewater discharge permit. This may be accomplished by one of the following:

1. Re-zoning areas currently designated as industrial to a residential zoning district. This would result in a net decrease in projected sewerage quantities. Or;
2. Limit industrial development to "dry" type industries with minimal water and sewer demands. This could be done on a case by case basis or as part of the zoning regulations.

Additional discussion regarding management of industrial growth can be found in Section 5 and Section 8.

It must be noted that while the annual average flow of the WWTF is limited, there are no discharge limitations on peak wastewater flows besides the WWTF physical hydraulic limitations. The WWTF was designed to hydraulically handle a peak instantaneous flow of 3.2 mgd. However, acceptable treatment of higher wastewater flows will be determined by the overall wastewater load to the secondary treatment process, as described below.

6.3.2 Wastewater Load Capacity

The Town's NPDES permit limits specific key loading parameters including BOD5, TSS, and total nitrogen (TN) effluent concentrations. The total mass daily load of these parameters (lbs/day) impact the secondary treatment process operation, and consequently, the effluent wastewater quality discharge. The BOD5 parameter is the most suitable indicator to evaluate the total load capacity of the WWTF. This presumes that all other influent parameters (TSS, total nitrogen) remain at relatively similar influent concentration ratios.

The WWTF loading was designed using both the annual average and maximum month loading conditions projected for a design year of 2030. However, when evaluating the total WWTF load capacity, the maximum month design load conditions provides the highest loading parameters that upgraded WWTF was designed to treat. It must be noted the maximum month design conditions assumed a flow of 1.54 mgd - approximately 0.69 mgd higher than the permitted average design flow.

Using WWTF design maximum month loading as the baseline condition, **Table 6-6** details the existing and projected wastewater loads to the WWTF, in addition to the remaining WWTF capacity at each of these scenarios. The influent secondary process concentrations for the current year (2017) and projected conditions were assumed to be the same as those which were developed in the Preliminary Design Report (Wright-Pierce, May 2014) for maximum month conditions (2030).

TABLE 6-6

CURRENT AND FUTURE WWTF LOAD CAPACITY

CONDITION	WWTF DESIGN (2030)	Current Year Max Month (2016)		Build-Out (2037)	
		Existing Load	Est. Remaining Capacity	Projected Load	Est. Remaining Capacity
BOD5, (lb/d)	**2,600**	**1,748**	**852**	**2,048**	**552**
TSS, (lb/d)	2,536	2,284	251	2,677	(141)[1]
TKN, (lb/d)	390	260	130	304	86
Ammonia-N, mg/L (lb/d)[(1)]	274	182	92	213	61

Note:
[1] Assumed influent TSS concentrations at maximum month conditions are conservative. Build-out projections for influent TSS concentrations are not considered to be a limiting factor for the WWTF treatment process.

Using the wastewater flow estimates developed in Section 3, the Town currently has an estimated additional BOD5 load capacity of 852 lbs/day (33%) at the existing (2017) maximum month condition of 1.04 mgd. Using the build-out projections from Section 5, the Town is estimated to have an additional 552 lbs/day (21%) of additional BOD5 load capacity at the projected build-out 2037 build-out scenario.

By applying similar BOD5 concentrations used for design maximum month conditions, this additional load capacity correlates to an approximate additional flow component of 0.26 mgd to the WWTF. This estimated load-based flow capacity is greater than what was calculated as remaining flow capacity in **Table 6-5 (**0.17 mgd) at the projected 2037 build-conditions. Based on this assessment, the WWTF will likely be limited by permitted annual average flow limitations as described in Section 6.3.1, and not influent loading treatment capacity. Therefore, build-out saturation pollutant loads were not evaluated.

6.3.3 Future Wastewater Flows

The adjacent Town of Newfields owns and operates a small aerated lagoon wastewater treatment facility located approximately 3 miles from the Newmarket WWTF. The Newfield's facility is permitted for a design flow of 0.117 mgd which discharges to the Squamscott River, a tributary to the Great Bay. The Newfields facility has not yet been issued a discharge permit with a nitrogen limit; however, Newfields may want to consider pumping their sewage to Newmarket to avoid having to build their own advanced treatment plant, if such a permit is issued in the future. Given the fact that Newmarket saturation build-out analysis shows that the Town could reach or exceed its permitted capacity (see Section 5), we would suggest that Newmarket only consider receiving additional flows from Newfields if EPA were willing to provide a permit increase of 0.117 mgd to accommodate Newfields' flow. The economic benefits to the town would need to be considered closely before making a decision to accept Newfields' sewage.

While there could be some operational economies of scale for both towns, Newmarket has a limited permitted WWTF discharge capacity available. A comprehensive evaluation would be required to fully define the impacts to the WWTF capacity, and the long-term economic benefits to the Town.

SECTION 7

Water Supply Capacity Analysis

SECTION 7

WATER SUPPLY CAPACITY ANALYSIS

7.1 WATER SUPPLY SOURCES

7.1.1 Bennett and Sewall Wells

The Bennett and Sewall Wells are located east of Newmarket's downtown area, just off Route 152. The Bennett Well was put online in 1971 and the Sewall Well was put online in 1986. These wells draw water from the Newmarket Plains sand and gravel aquifer. Water withdrawn from these wells has supplied the drinking water needs of the Town for several decades. These wells produce high quality groundwater requiring minimal treatment. Historically, the safe yield of Bennett and Sewall wells was estimated at their pumping rate of 220 gallons per minute (gpm) and 260 gpm, respectively.

Since the early 2000's, due to drought conditions and water demand, the Bennett and Sewall Wells have been repeatedly drawn down and sustained at extremely low levels. Several studies have been performed regarding the status of the Bennett and Sewall Wells, the latest of which was performed by Emery and Garrett Groundwater Investigations, LLC in April 2016. The Emery and Garrett report notes that "Since approximately 2011, the water levels in both production wells have declined as the amount of annual precipitation decreased." "A dramatic lowering of water levels in both production wells has occurred since early 2015."

Results of the Emery and Garrett report have indicated that the physical structure of the well, i.e. well screen, pump, etc., were not limiting factors in the production of the wells. The Bennett Well was estimated to be 91% efficient and the Sewall Well was estimated to be 73% efficient. The 1999 Dufresne Henry report estimated decline in groundwater levels in the Bennett Well at approximately 3% annually and at the Sewall Well at approximately 6% annually. A prediction was made that, if decline rates remained steady, the groundwater level would be at the top of the well screen in the Sewall Well by 2013 and in the Bennett Well by 2017. Drought conditions and pumping demands have varied greatly since 1999. The Emery and Garrett report noted that, as of February 26, 2016, the water level in the Bennett Well was 2.3 feet above the low water cutoff level and the Sewall Well was 3.25 feet below the low water cut off level. If withdrawals from the wells continue to increase and annual precipitation continues to decrease, the reported trends are assumed to continue.

The safe yield of Bennett and Sewall Wells was estimated at their pumping rate of 220 gpm and 260 gpm, respectively. The recent drought conditions have revealed the actual safe yield of these two wells is substantially lower than the historic understanding. A 2016 well assessment and our recent assessment have both reduced the safe yield based on recent drought conditions. Our assessment of the current safe yield of the Bennett Well to be 110 gpm and the safe yield of the Sewall Well at 155 gpm. This assessment is based on looking at potential recharge areas to the wells and the most recent information from drought years. This safe yield is the rate at which wells can be pumped without exceeding the natural replenishment of the aquifer. Pumps could theoretically withdraw at these rates 24-hours per day, seven days a week without depleting the aquifer. Water levels in Bennett and Sewall Wells need to monitored on a regular basis to verify they are not being over-pumped.

7.1.2 MacIntosh Well

The MacIntosh Well and future Tucker Well are located within the Piscassic River watershed on the south side of the Piscassic River, approximately 2 miles from where the Piscassic River joins the Lamprey River. The two well sites were chosen based on Emery and Garrett's town-wide investigation for potential production wells within the Town limits. Results of further well site investigation were reported in the August 2010 Hydrogeologic Investigation Report of Wells NGE-2B (MacIntosh Well) and NGE-1A (Tucker Well) by Emery and Garrett Groundwater, Inc. The MacIntosh Well was permitted for withdrawals up to 300 gpm (432,000 gallons per day (gpd). The Town developed the MacIntosh Well for production in 2015-2016.

The MacIntosh Well contains water with elevated levels of chloride, manganese and total dissolved solids (TDS). The well also has arsenic and sodium just under regulatory standards. In Weston and Sampson's December 2012 "Pilot Study Report MacIntosh Well Treatment Alternatives", alternatives for treating the MacIntosh Well water to acceptable standards were proposed. The two options proposed for treatment were blending with higher quality water or the use of an electro dialysis reversal (EDR) unit. Blending was chosen and the MacIntosh well was constructed with blending capabilities.

The MacIntosh Well is currently being blended with water from the distribution system, which is provided by the Bennett and Sewall wells. As of April 2017, the blend ratio was 52% MacIntosh water and 48% distribution system water. The State of New Hampshire (NHDES) will allow blending up to 60% MacIntosh water and 40% distribution water. If the MacIntosh Well is pumped at 300 gpm, it must be blended with 200 gpm from the distribution system. Based on the hydraulics of Newmarket's water distribution system, a minimum of 40 gpm from the Bennett/Sewall wells must flow down South Main Street (independent of the 200 gpm going to the Macintosh well site) to get the proper 60%/40% blend at Macintosh Well. This means at least 240 gpm must be pumped from the Bennett and Sewall wells to take full advantage of the 300 gpm from the MacIntosh well. It is possible to pump the Bennett and Sewall Wells at this rate; however, it requires both pumps to be online and operating near their combined safe yield.

7.1.3 Tucker Well

The Tucker Well site is located approximately one mile from the MacIntosh Well. The Town has permitted the Tucker Well for withdrawals up to 275 gpm (396,000 gallons per day (gpd), but has not purchased the site for development. The August 2010 Hydrogeologic Investigation Report of Wells NGE-2B (MacIntosh well) and NGE-1A (Tucker well) by Emery and Garrett Groundwater, Inc. indicated that the Tucker well would require treatment for elevated levels of arsenic, manganese, and radon.

7.1.4 Packers Falls Water Treatment Facility

The Town of Newmarket owns a 1.0 million gallons per day (mdg) surface water treatment facility. The facility draws water from the Follett's Brook and the Piscassic River. The facility was last upgraded in 1990 and was operated until the decision was made to temporarily shut down the facility in 1991. Challenging source water and process limitations made the production of quality drinking water difficult and inconsistent. The facility was operated occasionally when needed between 1991 and 2005, but was permanently shut down in 2005. The Town began relying solely on groundwater sources to meet their water production needs when the facility was shut down. The Town's master plan section on water resources has stated that, based on past evaluations, it is not economically feasible to upgrade the existing facility.

The plant continues to house the water system's SCADA equipment. It is also used for storage and office space. Upon completion of the new wastewater facility, the SCADA functions will be switched over from the water treatment facility to the wastewater treatment facility.

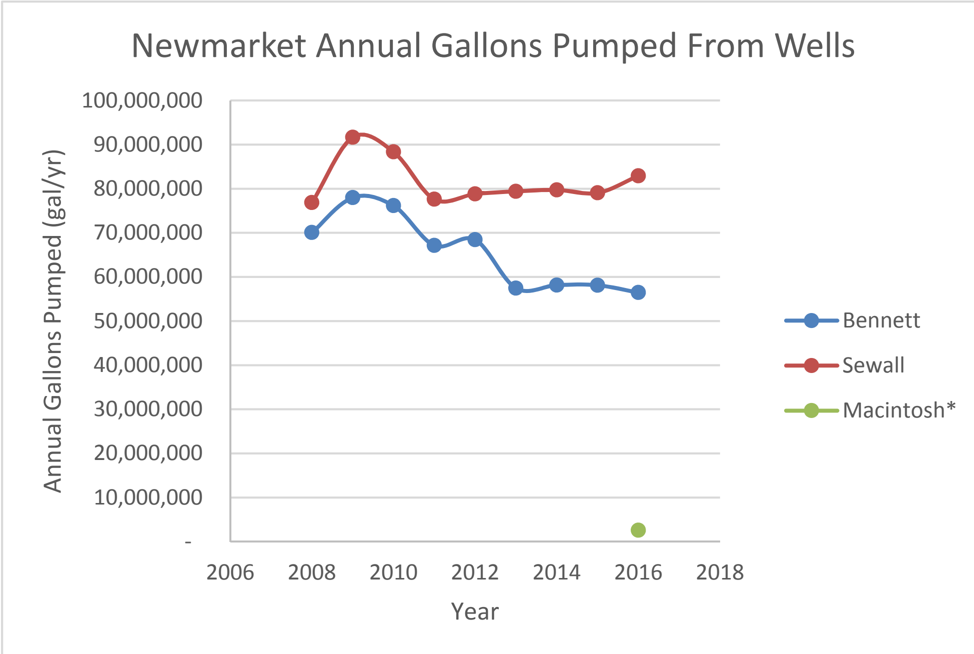
7.2 EXISTING WELL PRODUCTION

Information on the amount of water pumped from each well is monitored and recorded by source water meters at each well site. Source water meters are calibrated annually. Pumping information for the wells from 2008 to 2016 has been summarized in **Table 7-1** and **Figure 7-1** below.

TABLE 7-1
NEWMARKET WELL PRODUCTION

Year	Annual Withdrawal Totals (gal/yr)			Average Day (gpd)
	Bennett	Sewall	Macintosh*	
2008	70,068,624	76,849,056		402,514
2009	77,985,923	91,637,408		464,721
2010	76,151,205	88,333,401		450,643
2011	67,131,544	77,596,134		396,514
2012	68,431,604	78,825,050		403,443
2013	57,448,108	79,392,288		374,905
2014	58,155,025	79,722,737		377,747
2015	58,119,172	79,050,153		375,806
2016	56,455,690	82,925,890	2,599,500	388,989
*Operational Oct-Dec 2016				

FIGURE 7-1



The total gallons pumped from each well source varies annually, but has remained relatively steady since 2012. The MacIntosh well was brought online in October of 2016 and is anticipated to help decrease annual withdrawals from the Bennett and Sewall wells. Average daily well withdrawals from 2014 to 2016 (with water use restrictions in place) were approximately 380,848 gpd (352 gpm at 18-hour production) with greater max day demands.

7.3 ESTIMATED MAXIMUM WELL PRODUCTION VS. DEMAND

7.3.1 Water Industry Standards for Water Supply

A water system is considered to have adequate long-term water supply if it can meet the following system standards:

- **Condition #1** - The safe yield of the source of supply should exceed the projected average day demand in the planning period.
- **Condition #2** - The safe pumping capacity of the supply, with the largest pumping unit out of service, should be greater than or equal to the projected maximum-day demand in the planning period while pumping the wells an average of 16-18 hours a day to allow for recovery of the well between pumping intervals.

7.3.2 Safe Yield Analysis (Condition #1)

The combined safe yield of the Bennett Well (110 gpm), Sewall Well (155 gpm), and MacIntosh Well (300 gpm) is 565 gpm or 813,600 gpd. The average water demand over the past three years is approximately 378,470 gpd. The projected 2037 average water demand from the build-out analysis is 546,785 gpd. The projected saturation average water demand from the build-out analysis is 1,022,692 gpd. If zoning changes are made as discussed in Section 5.8, the saturation demand is reduced in the range of 240,000 gpd to 330,000 gpd depending on which combination of zoning changes are implemented. **Table 7-2** presents the possible maximum sustainable production of the wells under these conditions.

TABLE 7-2
THEORITICAL MAXIMUM WELL WITHDRAWAL CAPACITY
ALL WELLS ONLINE

Source	Safe Yield Withdrawal (gpm)	Possible Daily Withdrawal (gpd)	Possible Annual Withdrawal (gal/yr)
Bennett	110	158,400	57,816,000
Sewall	155	223,200	81,468,000
MacIntosh	300	432,000	157,680,000
TOTAL	565	813,600	296,964,000

The above table assumes MacIntosh Well can operate at it's safe yield. It is conceivable that due to blending requirements, the Town may not be able to consistently realize the full safe yield and the actual safe yield of the combined safe yields could be less than shown in Table 7-2.

The current water supply appears to meet the requirements of Condition #1 for an adequate water supply under present day and 2037 build-out demands, but does not meet the requirements for Condition #1 at saturation build-out as currently zoned.

We understand that due to requirements for blending, the MacIntosh Well requires either the Bennett and Sewall Wells to be operational for blending operations to function and water to be produced. In addition, a minimum of 40 gpm from Bennett or Sewall must be directed to South Main Street for blending to work properly. Therefore, if either the Bennett or Sewall Well are not in service, the MacIntosh Well must have the flow rate cut back. **Table 7-3** below shows the available supply in this scenario.

TABLE 7-3
SAFE YIELD ANALYSIS W/ EITHER BENNETT OR SEWALL OUT OF SERVICE

Source	Safe Yield Withdrawal (gpm)	Less 40 gpm (1)	60% Macintosh (gpm) (2)	Total Flow (gpm) 1+2+40 gpm	Daily Safe Yield (gpd)
Bennett and MacIntosh	110	70	105	215	309,600
Sewall and MacIntosh	155	115	173	328	472,300

Table 7-3 shows that with Sewall Well out of service, the Town cannot meet current average day demand (378,470 gpd) or any estimated future average day demands.

Having the MacIntosh Well in service has allowed the Town to cut back the pumping rate in the Bennett and Sewall Wells to be within their safe yield pumping rates (110 gpm and 155 gpm respectively). The primary near term issue facing the Town is, if either the Bennett or Sewall Wells go offline, the MacIntosh Well pumping rate must be cut back to achieve proper blending and the Town does not have capacity to safely meet average day demands.

7.3.3 Safe Pumping Capacity Analysis (Condition # 2)

Per industry standards, determination of the safe pumping capacity of the three existing wells assume the largest pump (MacIntosh Well Pump) would be out of service. Possible daily withdrawal would be limited to 518,400 gpd when pumped for18 hours. **Table 7-4** below shows the available supply when operating under the safe pumping capacity requirements of Condition #2.

TABLE 7-4
ESTIMATED SAFE PUMPING CAPACITY

MACINTOSH OFFLINE

Source	Pumping Capacity (gpm)	Possible Daily Withdrawal (gpd)
Bennett	220	237,600
Sewall	260	280,800
MacIntosh	0	0
TOTAL	480	518,400

The current water supply does not meet the requirements of Condition #2 for an adequate safe pumping capacity under current maximum day demands (574,600 gpd – average past three years).

7.3.4 Summary

In the following table (**Table 7-5**: Adequacy of Existing Water Supply System, we summarize the supply and demand information developed as part of this report.

TABLE 7-5

ADEQUACY OF EXISTING WATER SUPPLY SYSTEM

Demand Forecasts			Safe Yield Capacity			Safe Pumping Capacity	Safe Yield Adequacy			Safe Pumping Adequacy
	Average Demand (gpd)	Maximum Day Demand (gpd)	All Wells	Without Bennett Well	Without Sewall Well	Without MacIntosh Well	All Wells	Without Bennett Well	Without Sewall Well	Without MacIntosh Well
Current Demand (Avg. Past 3 years)	378,470	574,600	813,600	472,300	309,600	518,400	Yes	Yes	No	No
2037 Demand	502,100	903,780					Yes	No	No	No
Scenario #1 - Saturation Demand	1,022,692	1,840,842					No	No	No	No
Scenario #2 - Saturation Demand	852,690	1,534,850					Yes	No	No	No
Scenario #3 - Saturation Demand	764,620	1,376,310					Yes	No	No	No

Table 7-5 shows the current supply does not meet safe pumping capacity criteria (Condition #2) today or in the future. In addition, because of the blending requirement of MacIntosh Well, the current supply does not meet current or future safe yield requirements if Sewall Well is out of service or any future safe yield requirements if Bennett Well is out of service.

SECTION 8

Strategies for Water and Wastewater Management

SECTION 8

STRATEGIES FOR WATER AND WASTEWATER MANAGEMENT

8.1 INCREASING WATER SUPPLY CAPACITY

As identified in the Water Supply Capacity section of this study (Section 7), the Town has inadequate safe pumping capacity to meet current and projected future conditions and, therefore, has a need to expand safe pumping capacity of the water supply system. While theoretically the Town's water supplies have adequate safe yield to meet current and projected 2037 conditions, this is premised on the MacIntosh Well being able to operate at its maximum permitted capacity. Based on the water quality of the MacIntosh Well, state regulators require blending of MacIntosh water with higher quality water prior to being pumped to the distribution system. This condition requires Bennett and/or Sewall Wells to be operational anytime MacIntosh Well is pumping. If either of these two wells is off-line, safe yield is significantly reduced. Therefore, the Town has an immediate need increase the safe pumping capacity and the safe yield of the water supply system. From a review of past studies prepared for the Town, we have identified alternatives for increasing water supply capacity, as listed below.

8.1.1 MacIntosh Well Treatment and Tucker Well Development/Treatment

Past studies concluded that treatment of the MacIntosh Well supply would be required to allow for full utilization of the safe yield and permitted withdrawal of the MacIntosh Well supply (i.e. 300 gpm) when operating on its own. Treatment would eliminate the need for blending and allow for the Bennett and Sewall Wells to be operated independently of the MacIntosh Well. By treating the MacIntosh Well, the safe yield of the water supply system would be increased significantly when either the Bennett or Sewall Wells are offline, as shown in **Tables 8-1 and 8-2**. However, the safe pumping capacity would not be changed by treating the MacIntosh Well.

The Tucker Well has been permitted for withdrawal of up to 275 gallons per minute (gpm) (396,000 gallons per day (gpd), but has not been developed and requires treatment. If Tucker Well were added to the supply and the MacIntosh and Tucker Wells were operated together, they would be permitted for a combined withdrawal of 575 gpm (828,000 gpd) if treated. Otherwise their combined capacity is limited by the need to blend. By adding the Tucker Well, the safe pumping capacity of the water supply system would be increase as shown in **Table 8-2**.

The August 2010 Hydrogeologic Investigation Report of Wells NGE-2B (MacIntosh Well) and NGE-1A (Tucker well) by Emery and Garrett Groundwater, Inc. indicated that the Tucker Well would require treatment for elevated levels of arsenic, manganese and radon. Blending of this well with distribution water to reach acceptable water quality may be possible, but will restrict the useful production of the well. It is our understanding that treatment technology has not been piloted for the Tucker Well, but the well has been permitted and the land has been purchased.

In 2012, Weston and Sampson piloted an Electro Dialysis Reversal (EDR) unit to successfully treat the MacIntosh Well water to acceptable standards. The August 2010 Hydrogeologic Investigation Report of Wells NGE-2B (MacIntosh Well) and NGE-1A (Tucker Well) by Emery and Garrett Groundwater, Inc. indicated that concentrations of sodium, chloride and manganese may decrease during periods of extended pumping. Overtime, as the well is operated on a regular schedule, concentrations may decrease as the sources of chloride, sodium, and manganese are depleted. Alternative methods of treatment may be feasible if the MacIntosh Well water quality improves. If treatment of either MacIntosh or Tucker Wells is pursued, further analysis of water quality and possible treatment technologies would be advisable, especially if in the future, there is a possibility that the Tucker Well may be developed and treated with the MacIntosh Well in a combined facility.

TABLE 8-1

SAFE YIELD ANALYSIS WITH EITHER BENNETT OR SEWALL WELLS OUT OF SERVICE AND TREATMENT OF MACINTOSH WELL

Source	Safe Yield Withdrawal (gpm) (1)	Macintosh (gpm) (2)	Total Flow (gpm) 1+2	Daily Safe Yield (gpd)
Bennett	110	300	410	590,400
Sewall	155	300	455	655,200

Table 8-1 shows that with Bennett or Sewall Well out of service and MacIntosh Well treated, the Town would have sufficient safe yield to meet current average day demand (378,470 gpd) and estimated 2037 average day demand (502,100 gpd).

A 2010 study of treatment alternatives indicates that if treatment were to be pursued, EDR would be the preferred method. Review of previous studies indicate a conceptual project cost estimate for treating both MacIntosh and Tucker Wells would be **$3.7M**. The actual cost will vary depending present water quality in each well and type of treatment selected. This cost needs to be verified prior to budgeting for this project.

The 2016 Tucker Well Connection Alternatives Memorandum for the Town of Newmarket gave an estimated cost of **$2.0M** for development of the Tucker Well. Should development of the Tucker well be pursued, we recommend that further analysis of treatment options and an in-depth cost estimate be performed.

8.1.2 Artificial Recharge of Bennett and Sewall Wells

In 2002, during a period of severe drought, artificial recharge of the Newmarket Plains Aquifer was first implemented. This recharge allowed use of the Bennett and Sewall Wells to continue despite their levels being dangerously low. Water for recharge was provided from the Packer's Falls surface water treatment plant, which was in operation during the severe drought to supplement well water.

Hydraulically, the artificial recharge could sufficiently recharge the aquifer; however, water quality problems arose. Water samples from pumped water failed testing for disinfection byproducts due to organics carried over from recharge source water. Artificial recharge was stopped following water quality testing.

Further investigation was performed in 2008 by Emery and Garrett Groundwater, Inc. and a report was produced in 2009 on the use of artificial recharge in the Newmarket Plains aquifer. Results of the report indicated that artificial recharge, using water pumped from the Lamprey River, was a viable option for increasing the amount of water in the Newmarket Plains aquifer. It was estimated that approximately185 gpm (267,000 gpd) more water would be available for withdrawal if 0.38 million gallons per day (mgd) were applied to the recharge basins. The possibility of installing an additional production well in the Aquifer to capture excess artificial recharge was also discussed. While artificial recharge would increase the safe yield and safe pumping capacity of the water supply system, it would not meet the safe pumping requirements of the 2037 projections and would not be a complete solution.

The Emery and Garrett investigation indicates that artificial recharge is a viable option for increasing water available for withdrawal from the Newmarket Plains aquifer. One of the potential issues with artificial recharge is over time, surface water influence on the groundwater (higher organic content) may cause problems with disinfection byproducts (DBPs). DBPs are formed when chlorine reacts with the organics. DBPs are known carcinogens and are regulated by the State and federal health agencies. Given these concerns and the fact that recharge will not solve all the safe yield (safe pumping capacity) needs alone, the Tucker and MacIntosh Well strategies would likely be the preferred near-term strategies.

8.1.3 Obtaining Future Well Sites

Potential areas of the town where new wells could be developed have been identified in past Town-wide studies. One or more new wells could potentially address the safe yield and pumping capacity issues. At this point, insufficient information is available to know whether this option could be a cost-effective alternative to other options. It would take extensive testing to understand the viability of this option. For this reason, the other options would likely be preferred. That said, it may be advantageous for the Town to consider aquifer protection zones and possibly obtaining potential future well sites to secure access and limit development in potential wellhead protection areas to preserve future well development possibilities.

For example, the 2009 water resources section of the Town's master plan identified the land between Route 108 and New Road, located in the B-2 district, as a potential drinking water source. Preliminary well drilling data for two bedrock test wells in this area, from approximately 1999, indicated promising water yields. A past Emery and Garrett study identified this area as the next highest potential well site after the MacIntosh and Tucker well sites. This area is in the B-2 zoning district and currently has little development. Potential future well sites, which the Town may someday require, could be influenced by future development. Proactive protection of potential future well sites and aquifers is encouraged.

8.1.4 Safe Pumping Capacity Increase Strategy

The Town is limited in safe pumping capacity both now and in the future. Adding Tucker Well would increase the safe pumping capacity of the water supply system, but not enough to meet future requirements (see **Tables 8-2 and 8-3**). An option to increase safe pumping capacity (i.e., with the largest pump out of service) is to install a 350 gpm pump in Tucker Well and install a back-up well at the Tucker Well site. For purposes of this analysis, it is assumed that a backup well on the Tucker site would be preferred over the MacIntosh site because the Tucker Well appears to have higher quality water.

The safe yield of Tucker Well is 396,000 gpd. Pumping at 350 gpm for 18 hours is 378,000 gallons (below the safe yield). This is similar to our understanding of how MacIntosh Well can be operated at 350 gpm. Pumping at this rate for 18 hours is well below the MacIntosh safe yield of 432,000 gpd. By adding a back-up 350 gpm well at the Tucker site, the Town would have a safe pumping capacity of 1,180 gpm (1,274,400 gpd in 18 hours). The Town could meet Condition #2 for 2,037 Maximum Day Demands (984,000 gpd) and Saturation Demand Build-out Scenario #3 (1,256,054 gpd).

8.1.5 Demand Management

As discussed in Sections 4 and 5, one way to minimize the need for expanded safe yield and safe pumping capacity is to lower projected future demand by modifying the zoning and/or controlling the nature of the development. **Table 7-5** shows how changing zoning or water demand assumptions (Scenario #2 and Scenario #3) lowered the projected Scenario #1 Saturation Build-Out demands so that safe yield (but not safe pumping capacity) can be met with current supply. Ultimately, the demand management may be required to keep the wastewater demands within the current wastewater treatment plant discharge permit limit of 0.85 mgd as discussed in Section 8.3.

8.1.6 Summary of Most Probable Water Supply Solutions

Table 8-2 provides a summary of the Safe Yield and Safe Pumping Capacity under various conditions. Note that when adding Tucker Well without treatment of both the Tucker and MacIntosh Wells, the safe yield does not increase because of the need to blend with the limited supply of Bennett and Sewall Wells. **Table 8-3** Provides a summary of the Town's ability to meet water industry standards based on options to increase water supply capacity.

TABLE 8-2
SUMMARY OF SAFE YIELD AND SAFE PUMPING CAPACITY

	Safe Yield (gpd) – All Wells Online	Safe Yield (gpd) without Bennett Well	Safe Yield (gpd) without Sewall Well	Safe Pumping Capacity (gpd) without MacIntosh Well
Current Supply	813,600	472,300	309,600	518,400
With MacIntosh Treated	813,600	655,200	590,400	518,400
With Tucker Well	813,600	472,300	309,600	815,400
With MacIntosh and Tucker Wells Treated	1,209,600	1,051,200	986,400	815,400
With Artificial Recharge	1,080,000	795,600	633,000	648,000
With Tucker Well and Back-up	813,600	472,300	309,600	1,274,400

TABLE 8-3

ABILITY TO MEET WATER INDUSTRY STANDARDS FOR WATER SUPPLY

	Condition #1	Condition #1a	Condition #1b	Condition #2
	Safe Yield -All Wells Online	Safe Yield Without Bennett Well	Safe Yield Without Sewall Well	Safe Pumping Capacity Without MacIntosh Well
CURRENT CONDITION				
Current Supply	Yes	Yes	No	No
With MacIntosh Well Treated	Yes	Yes	Yes	No
With Tucker Well	Yes	Yes	No	Yes
With Tucker Well and MacIntosh Well Treated	Yes	Yes	Yes	Yes
Artificial Recharge	Yes	Yes	Yes	Yes
With Tucker Well and Back-up	Yes	Yes	No	Yes
2037 PROJECTIONS				
Current Supply	Yes	No	No	No
With MacIntosh Well Treated	Yes	Yes	Yes	No
With Tucker Well	Yes	No	No	No
With Tucker Well and MacIntosh Well Treated	Yes	Yes	Yes	No
Artificial Recharge	Yes	Yes	Yes	No
With Tucker Well and Back-up	Yes	No	No	Yes

TABLE 8-3

ABILITY TO MEET WATER INDUSTRY STANDARDS FOR WATER SUPPLY (*CONTINUED*)

	Condition #1	Condition #1a	Condition #1b	Condition #2
	Safe Yield -All Wells Online	Safe Yield Without Bennett Well	Safe Yield Without Sewall Well	Safe Pumping Capacity Without MacIntosh Well
SCENARIO #1 - SATURATION BUILD-OUT (AS ZONED)				
Current Supply	No	No	No	No
With MacIntosh Well Treated	No	No	No	No
With Tucker Well	No	No	No	No
With Tucker Well and MacIntosh Well Treated	Yes	Yes	No	No
Artificial Recharge	Yes	No	No	No
With Tucker Well and Back-up	No	No	No	No
SCENARIO #2 - SATURATION BUILD-OUT				
Current Supply	Yes	No	No	No
With MacIntosh Well Treated	Yes	No	No	No
With Tucker Well	Yes	No	No	No
With Tucker Well and MacIntosh Well Treated	Yes	Yes	Yes	No
Artificial Recharge	Yes	Yes	No	No
With Tucker Well and Back-up	Yes	No	No	No
SCENARIO #3 - SATURATION BUILD-OUT				
Current Supply	Yes	No	No	No
With MacIntosh Well Treated	Yes	No	No	No
With Tucker Well	Yes	No	No	No
With Tucker Well and MacIntosh Well Treated	Yes	Yes	Yes	No
Artificial Recharge	Yes	Yes	No	No
With Tucker Well and Back-up	Yes	No	No	Yes

* Current Supply = Bennett Well, Sewall Well and MacIntosh Well Untreated.

Based on the above summary of past evaluations of alternatives, the most promising long-term combination of alternatives to address safe yield and safe pumping through the year 2037 is to add Tucker Well and treat both the Tucker and MacIntosh Wells. In addition, the construction of a backup well at the Tucker Well site will allow the Town to meet safe pumping. Proceeding with this alternative will also allow the Town to meet Scenarios #2 and #3 saturation build-out conditions. Based on past cost estimates, the cost for these solutions would be approximately $5.7 million. Additional study of the treatment options and project costs is warranted as the next step to confirm and fine-tune solutions, costs, funding options, financial capability, implementation options, etc.

8.2 OTHER WATER SYSTEM IMPROVEMENTS/CONSIDERATIONS

While the focus of this study is the adequacy of the water supply, we do want to note that past studies have identified other water system improvements that may be required moving forward as discussed below.

8.2.1 Additional Water Storage

Currently the Town of Newmarket operates and maintains one water storage tank, the Great Hill Tank. The Great Hill Tank provides additional water storage to normalize water demands in the distribution system and provide fire flows. AECOM's September 2011 Water System Update and Capital Improvement Plan (CIP) for the Town of Newmarket gave the tank's usable storage as 228,600 gallons. The CIP also noted that "With the MacIntosh and Tucker wells online, the ability to replenish storage will be improved; however, additional storage will be needed to provide water for equalization, firefighting and emergency supply."

The April 2016 letter report on the Bennett and Sewall Production Wells by Emery and Garrett Groundwater Investigations, LLC gave several operations recommendations to help mitigate water shortages during the summer and fall of 2016. One suggestion was to operate production wells at lower rates for longer periods of time to minimize well draw down. It should be noted that while this would allow for pumps to be run longer, it does not allow for greater daily withdrawals than the wells were permitted for. With the addition of the MacIntosh Well and with the possible addition of the Tucker Well, there will be adequate safe yield capacity for future average demands, but not sufficient safe pumping capacity to meet peak day demands. Additional storage may delay the need for the backup well at the Tucker source. Potentially, this issue should be considered as part of the recommended study to fine-tune the water capacity solutions.

AECOM's September 2011 Water System Update and Capital Improvement Plan for the Town of Newmarket assumed the installation of a 750,000-gallon water storage tank with a connecting water main. The CIP gave an estimated 2010 cost of $2,240,000 for construction of both the storage tank and the main. It is not fully understood what items were included in AECOM's estimate. The December 2010 ENR 20 city average index was 8952 and the March 2017 ENR 20 city average index was 10278. Adjusting the cost using the index values yields an updated estimated cost of **$2,571,796**. Should installation of a new storage tank be pursued, we recommend that further analysis of the distribution system and an in-depth cost estimate be performed.

8.2.2 Water Distribution Piping Renewal

Water losses can occur from leaks, flushing, unrecorded firefighting use and numerous other factors. Overall, the Town's Water Conservation Plan is well defined and manages the detection and remedy of water losses well. Source meters are calibrated annually, water audits are performed annually, and additional water conservation measures, which could be implemented, have been identified in the annual report.

As water mains in the Town's distribution system continue to age, minor water losses due to corrosion and age-related degradation will continue to increase. Replacing mains and services in the system will renew the water infrastructure and minimize losses. Ideally replacing or renewing 0.5 to 1% of the distribution system per year to maintain system reliability. Water losses should be monitored closely and the Town's leak detection equipment should be utilized to minimize losses and assist in determining sections for replacement.

Further strategies identified in both the Town's Water Conservation Plan and AWWA's M52 "Water Conservation Programs - A Planning Manual" include incentives for the use of water efficient fixtures and fittings, implementing irrigation system restrictions, and the use of native plant species in landscaping. If these strategies are to be considered, the level of effort and cost should be further analyzed. The Town's CIP calls out multiple sections of main recommended for replacement, however further analysis should be performed if the intention is to minimize water loss.

8.2.3 Improved Water Monitoring

Water meters are used to accurately measure water use per home. Data gathered from water meters is used to develop both water and sewer bills, as well as perform water audits. Maintaining water meters is an investment in the ability to collect revenue and track water use. New meters typically improve accuracy and, depending on how old existing meters are, can provide a relatively quick return on investment.

Per the Water Department's Water Conservation plan, the Town installed approximately 500 new water meters from 2008 to 2009, and 1400 new meters in 2010. The remaining meters were installed prior to 2005. It is estimated from service count data that, out of the Town's 3,695 water service connections, 1,795, or 49%, of water service connections have meters that are 11 or more years old. The average useful life of a home service water meter is usually regarded as 15 to 20 years. At the time of the conservation plan's publishing, a database was being created to track meter ages and failures to determine when meters need replacement. Meter replacement projects should be regularly implemented to replace aging meters and maintain system accuracy.

8.2.4 Cost Recovery System Review

When considering the growth impacts on water and sewer infrastructure systems, it is often advisable to evaluate the adequacy of the Town's cost recovery systems (e.g., user charge system, impact fees, etc.). **Industry best practices suggest that user charge systems recover not only the routine operations and maintenance cost but also include depreciation cost so the community has adequate resources to sustainably maintain all its water and sewer infrastructure assets. With respect to managing the financial impacts of development on the water and sewer system, industry best practice is to have the beneficiaries of new development pay for the cost to service the development, as opposed to having existing users subsidize the cost of growth.** This usually takes the form of an impact fee or connection fee. Depending on when the Town's cost recovery systems were last updated, the Town may want to review and update these systems as appropriate.

8.2.5 Hydraulic Analysis to Accommodate Growth

New water lines may need to be extended and some existing water lines enlarged to serve the projected growth. As development scenarios are developed, the impacts on the water pipe network should be explored and the cost to address these impacts developed. If the Town passes the infrastructure costs to accommodate growth onto developers, as is the industry best practice, it will be important to inform developers of the cost they will incur early in the process, as these costs could significantly impact their development strategy.

8.3 WASTEWATER CAPACITY STRATEGIES

The Town will complete construction of a new wastewater treatment facility in 2017. The new facility has been sized to accommodate wastewater flows for 20-year build-out scenarios, but not to accommodate the Scenario #1 (as zoned) saturation build-out condition. Given the significant wastewater discharge permit constraints facing the Town, one or more of the following demand management options should be implemented to limit the future demands on the wastewater treatment plant to the current permit limit.

1. Reduce the saturation build-out demands by strictly controlling the type of industrial growth (e.g., "dry" vs. "wet" industries) permitted in the future.
2. Future Zoning Changes: Existing undeveloped zones with potentially high future per-acre water demand could be rezoned to a classification with lower potential water demand.
3. Inflow and Infiltration Control: Continue Town-wide efforts to identify and remove significant sources of inflow and infiltration in the existing sewer system.

8.4 OTHER WASTEWATER SYSTEM IMPROVEMENTS

Currently the Town of Newmarket operates and maintains the WWTF which is presently undergoing a comprehensive upgrade. The upgrade will provide the Town with wastewater treatment compliant with their current interim nitrogen permit (< 8 mg/L), but would require future upgrades if a future nitrogen limit of < 3 mg/L was imposed. The Town has actively developed a Capital Improvements Plan (CIP) for the WWTF and based on discussions, will implement an asset renewal program for all new equipment installed as part of the current upgrade.

In addition, the Town operates and maintains six (6) wastewater pumping stations. These pumping stations range from approximately 250 gpm to over 2,000 gpm. The Town completed a pump station CIP which was updated as recently as 2016. The Town has reserved capital budget in recent years for asset renewal projects. It is recommended that the Town continue to utilize the pump station CIP to help in advancing the asset renewal program for the pump stations.

8.4.1 Wastewater Infrastructure Renewal

The Town's largest wastewater system investment is in the buried pipes and an ongoing asset management and asset renewal program is recommended. Unwanted infiltration and inflow to wastewater collection systems is caused by pipe breaks, aging pipes, combined storm sewers, and numerous other factors. Evaluating sewer infrastructure through I/I analysis and replacing aging infrastructure is an effective method of renewing infrastructure.

As sewer pipes in the Town's collection system continue to age, I/I could increase. Replacing and/or rehabilitating aging sewer mains and services in the system will be an important component of the Town's asset management strategy. Industry standard is to invest from 0.3 – 1% of the replacement value of the collection system to maintain the overall integrity of the system. I/I should be monitored closely and the Town should have I/I analysis performed periodically assist in determining sections for replacement.

8.4.2 Cost Recovery Systems

When considering the growth impacts on water and sewer infrastructure systems, it is often advisable to evaluate the adequacy of the Town's cost recovery systems (e.g., user charge system, impact fees, etc.). Industry best practices suggest that user charge systems recover not only the routine operations and maintenance cost, but also include depreciation cost so the community has adequate resources to sustainably maintain all its water and sewer infrastructure assets. The Town has been proactive in managing sewer rates to provide adequate funds for both current and future projects for wastewater. As described previously in this section, continued updates and budget implementation of a Capital Improvements Plan will provide the basis for rate setting.

With respect to managing the financial impacts of future development on the water and sewer system, industry best practice is to have the beneficiaries of new development pay for the cost to service the development, as opposed to having existing users subsidize the cost of growth. This usually takes the form of an impact fee or connection fee. Depending on when the Town's cost recovery systems were last updated, the Town may want to review and update these systems as appropriate. Depending on the type of industry (dry vs. wet), the Town may also choose to develop a pollutant surcharge fee for industrial users contributing a larger pollutant load per unit volume (e.g., nitrogen, TSS, BOD, etc.) compared average residential/commercial sewerage. If significant industrial growth occurs within the Town, it is recommended that an industrial pre-treatment program is developed alongside descriptions of pollutant surcharge fees.

8.4.3 Minimizing I/I from Future Development

Given the strong desire to minimize future wastewater flows, it is important to establish construction and construction inspection requirement standards for all new development to minimize I/I from new development.

8.4.4 Non-point Source Nitrogen Control and Relationship to New Development

The major treatment plant upgrade that is ongoing is being driven by water quality impairment in Great Bay. State and federal environmental regulators understand that the treatment plant upgrades around Great Bay will not alone improve Great Bay to the desired level. This is due to the large amount of nitrogen pollution flowing to Great Bay from what is referred to as non-point sources (NPSs) of nitrogen pollution. NPSs include septic systems, stormwater, lawn and agricultural fertilizers, etc.

Due to the NPS concerns, EPA has mandated that the Town take steps to reduce NPSs of nitrogen from reaching the Bay. If the Town is unsuccessful adequately reducing the NPSs, EPA will mandate that the Town further upgrade its wastewater treatment plant to achieve a 3 mg/L – TN limit. So, the Town has major incentive to minimize NPSs of nitrogen pollution.

The NPS issue is the reason the Town has regulatory mandates to address stormwater and other NPSs, and to monitor river quality. Moving forward, it will be in the Town's best interest to minimize the nitrogen footprint of new development through regulation. In the context of this study, this might include a mandate for all new development in sensitive coastal areas (like all development within 200 yards of a first order or higher stream, river or mapped wetland, or the bay) be served by the sewer system or by an on-lot sewage disposal system that will remove nitrogen to below 10 mg/L TN. There are a variety of other low impact development (LID) strategies to minimize nitrogen pollution that should be encouraged and/or mandated.

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